Dissertation on

"AN ANALYTICAL STUDY TO DETERMINE THE RISKFACTORS FOR DESCEMET'S MEMBRANE DETACHMENT FOR PATIENTS AWAITING CATARACT SURGERY"

Submitted in partial fulfillment of requirements of

MASTER OF SURGERY DEGREE

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CHENNAI

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CERTIFICATE FROM GUIDE

This is to certify that this dissertation entitled **"AN ANALYTICAL STUDY TO DETERMINE THE RISKFACTORS FOR DESCEMET'S MEMBRANE DETACHMENT FOR PATIENTS AWAITING CATARACT SURGERY "** is a bonafide record of research work done by **Dr.VIDHUBALA.G** Post Graduate Resident in Department of Ophthalmology, Madurai Medical College, Madurai.

She has submitted this in partial fulfillment of the regulations laid down by The Tamil Nadu Dr. M.G.R. Medical University, for the award of Master of Surgery Degree Branch III (Ophthalmology), under my guidance and supervision during the academic years 2016-2018.

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DECLARATION

I, **Dr.VIDHUBALA.G** hereby solemnly declare that, this dissertation titled **"AN ANALYTICAL STUDY TO DETERMINE THE RISKFACTORS FOR DESCEMET'S MEMBRANE DETACHMENT FOR PATIENTS AWAITING CATARACT SURGERY"** was done by me.

I also declare that this bonafide work / a part of this work was not submitted by me / anyone else, for any award, for Degree / Diploma to any other University / Board either in India / abroad. This is submitted to The Tamilnadu Dr. M. G. R. Medical University, Chennai in partial fulfilment of the rules and regulations for the award of Master of Surgery degree Branch -III (Ophthalmology) to be held in May 2018.

Place: Madurai

Date :

(Dr.Vidhubala.G)

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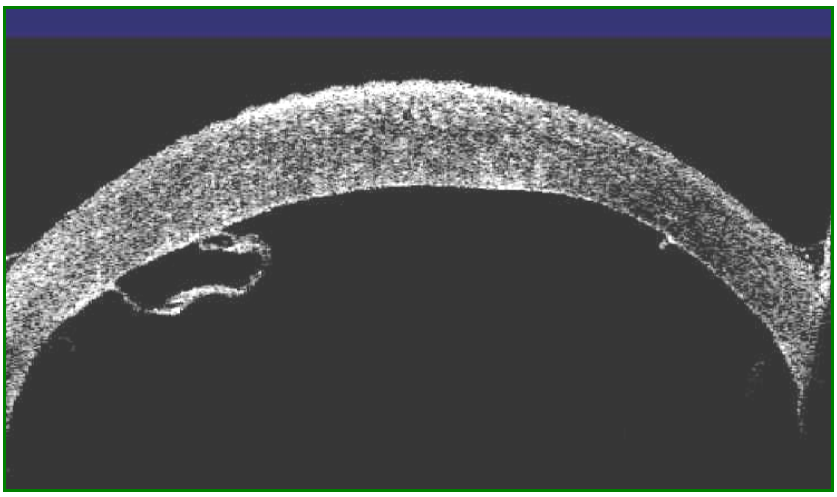
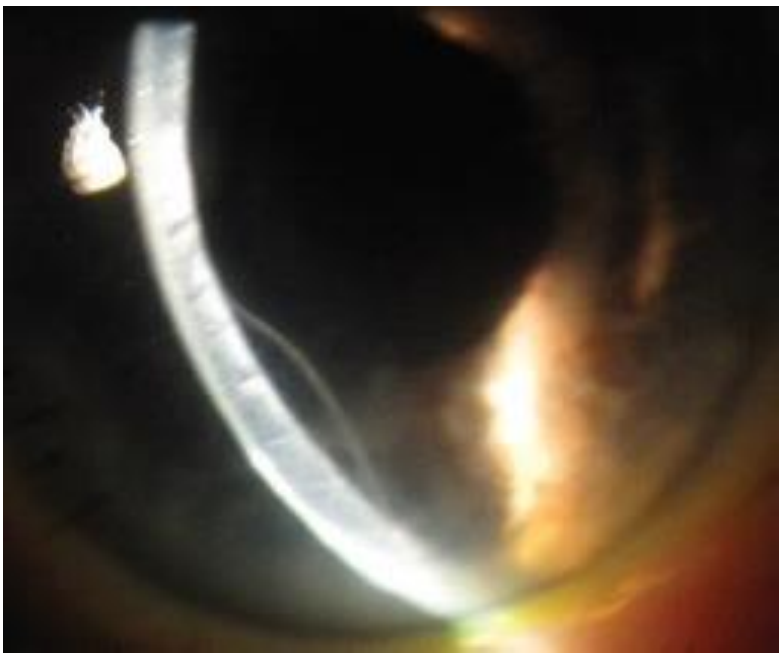
INTRODUCTION

Descemet's membrane is a thick basement membrane that lines the posterior surface of the cornea above the corneal endothelium. It is made up of collagen(73%) and glycoproteins. The collagen differs from typical connective tissue collagen in that it lacks the typical 640-A banded collagen fibrils and have a high content of hydroxyproline, glycine and hydroxyglycine. Unlike stroma, the Descemet's membrane does not contain glycosaminoglycans. The collagen is insoluble and extremely resistant to chemical and enzymatic actions. This accounts for the resistance offered by Descemet's membrane (DM) to trauma, chemical agents, infection and a barrier to perforation in deep corneal ulcers. In ocular physiology, Descemet membrane with it's endothelium has a vital role in maintaining corneal transparency.

Descemet's membrane detachment (DMD) or tears may occur as a complication of intraocular procedures. It was first reported in 1927 by Weve. Surgical trauma is the predisposing factor in DMD and is reported after cataract surgery, viscocanalostomy, trabeculectomy, iridectomy, penetrating keratoplasty and cyclodialysis. It is most commonly encountered during cataract surgery and diagnosis is made intra-operatively in 50 % of the cases. Rarely, it can develop late in the post – op

period varying from weeks to months. Clinical presentation is that of decreased vision associated with corneal edema. If left untreated, edema may persist, leading to corneal decompensation and vision loss. DMD may manifest with loss of vision due to corneal edema and the presence of Descemet's membrane (DM) folds. The incidence of DMD has been reported from 2% to 6% and from 0% to 5% during extracapsular and phacoemulsification cataract surgery, respectively.

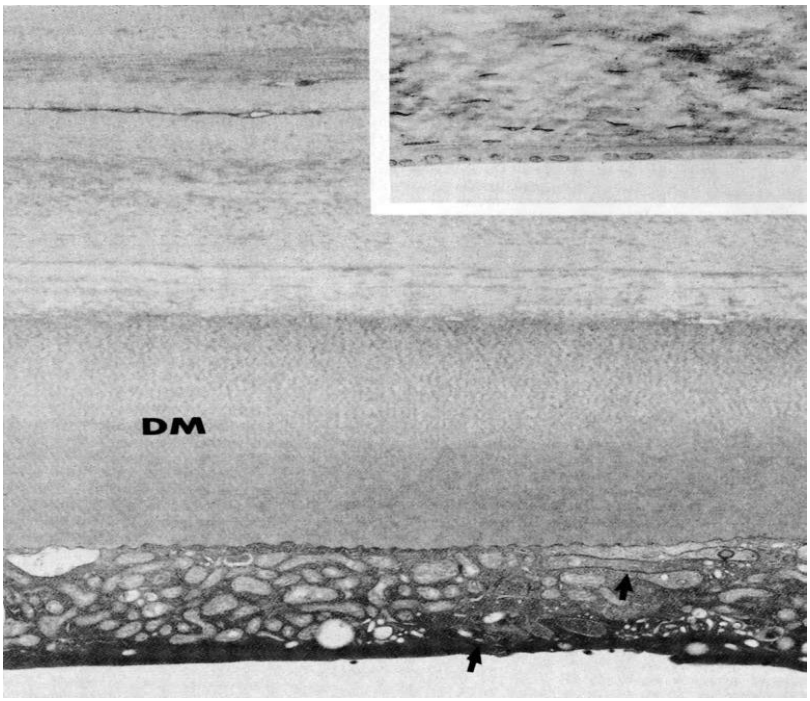




DEVELOPMENT OF CORNEA

The primary function of the cornea and its surface tear film is to refract and transmit light to the lens and retina. Because the cornea is such a major functional tissue of the eye and because damage to or disease of the cornea has serious visual consequences, its structure, function, and pathology have received much attention.

The cornea is a highly specialized tissue that refracts and transmits light to the lens and retina. In humans, it is about twice as thick at the periphery than at the center (1 mm compared with 0.5 mm). The tissue of the cornea appears simple in composition because it is composed only of an outer stratified squamous non keratinized epithelium, an inner dense connective tissue stroma with its resident fibroblast-like keratocytes, and a monolayered cuboidal endothelium bordering the anterior chamber . The cornea, however, actually is highly ordered and complexly arranged in comparison with other tissues of the body. Its transparency, avascularity, and highly ordered structure make it unique among all tissues of the body. Cells of all layers interact with and influence each others' functions. They do not act alone, but mediators (cytokines) expressed by one cell type influence cells of adjacent layers.



Micrographs of posterior corneal stroma, Descemet's membrane (DM), and the corneal endothelium. The *inset* is a light micrograph section from a newborn with its comparatively thin Descemet's membrane. The inner- banded layer was deposited by the endothelium during fetal life.

THE ANATOMY

Descemet's membrane is the basement membrane of the corneal endothelium. It is synthesized by the endothelium and assembled at the basal surface of the cell layer. At birth, the human Descemet's membrane is approximately 3 μm wide, but, by late adulthood, it can measure up to 12 μm . Its accrual during life is comparable with the thickening of the other basement membranes of the body, including that of the corneal epithelium .

Descemet's membrane is the thick extracellular matrix synthesized and secreted by the corneal endothelium. In adults this matrix consists of two layers. An anterior, 'banded' layer is formed during fetal development , " *fetal Descemet's membrane*" and consists of highly organized collagen lamellae and proteoglycans. A posterior 'amorphous' layer is synthesized after birth and is less organized than the fetal layer.

Adult Descemet's membrane contains fibronectin, laminin, type IV and type VIII collagen, as well as heparan sulfate and dermatan sulfate proteoglycan. How these constituents are assembled to form the highly ordered lattice of the fetal membrane and the more randomly organized adult membrane remains unresolved. Corneal endothelial cells slowly synthesize and secrete basement membrane material throughout life. In young adults the posterior layer measures ~2 mm, but increases to ~10 mm

in older individuals. The anterior banded layer remains the same thickness regardless of age . The positive correlation between age and Descemet's membrane thickness suggests that there is little, if any, destruction of previously formed basement membrane material. This provides a type of historic record of corneal endothelial cell's life expectancy and function , and has been used to study ultrastructurally, the development of endothelial diseases or dystrophies. By comparing the morphology and thickness of Descemet's membrane in normal and diseased corneas, it is possible to determine the relative point in time in which the ability of corneal endothelial cells to synthesize and secrete normal Descemet's membrane is compromised.

Individual endothelial cells can produce excess extracellular matrix material, resulting in the formation of focal or nodular thickenings in Descemet's membrane. These thickenings, called Hassall–Henle bodies or 'warts', are frequently found in cells at the corneal periphery. Similar structures are termed 'guttatae' when they are located centrally within the cornea. The number of these focal thickenings increases with age, in certain endothelial dystrophies, such as Fuchs' dystrophy, and as the result of inflammation.

Descemet's membrane is unique among basement membranes, not so much in its composition, but in its thickness and regional variation in

structure. Why this basement membrane is so thick remains an unanswered question. Basement membranes in general are believed to serve as substrates of epithelial cell layers, functioning in the filtering of solutes passing to and from the epithelia and serving as substrates that induce polarity and differentiation of the overlying epithelium.

The nature of structural specializations that anchor endothelial cells to Descemet's membrane is unclear, although focal areas of increased electron density suggest the presence of anchoring plaques . Proteins expressed in corneal endothelial cells that are known to facilitate normal cell–substrate anchoring include vinculin , talin , β3- integrin , and α-v, β5-integrin.

THE UNIQUE PROPERTIES OF DESCEMET MEMBRANE

Waring & co-workers have pointed to three characteristic properties of DM to account for many pathologic changes seen clinically and histologically:

1. **Elasticity**

   The distensibity of DM permits stretching ,or distortion, followed by a return to its original shape. When stroma imbibes fluid and cornea thickens the increased volume is distributed posteriorly, producing bowing and folding of the membrane, whereas anterior cornea retains a fixed curvature. If the stroma is thin, stretching of the membrane may

result in a descemetocele. Part of the resistance of DM to perforation results from its copact collagen structure and distensibility, but the pressure developed within the descemetocele is also an important factor. Because the tension on the wall of the sphereis proportional to the pressure exertedmultiplied by the radius of the sphere,the short radius of the descemetocele reduces the pressure on its wallto about $1/25^{th}$ of that on sclera, and the force of the intraocular pressure is is partially dissipated (Laplace's law). Nevertheless the elasticity of DM is limited. Acute stretching (buphthalmos, keratoconus) may cause a breakdown in it . Recently more sophisticated training techniques and electron microscopy refute earlier claims that the membrane contains elastic fibres. The reason for its elasticity is unknown, although other basement membranes such as that of a lens capsule have a similar property.

2. Barrier to penetration by cells and vessels

Leuckocytes and bacteria do not penetrate an intact Descemet's membrane, a property confining them to cornea in deep corneal ulcers until the membrane is ruptured by the action of proteolytic enzymes. Newly formed blood vessels do not penetrate this glassy membrane , and anterior synechiae adherent to it are unable to send vessels into the stroma.

3. **Resistance to autolysis**

Because Descemet's membrane is not digested by autolytic processes of the body, it remains undisturbed indefinitely in ectopic locations or abnormal configurations. Changes that occur in childhood are often observed during routine examination years later.

CORNEAL TRANSPARENCY

The transparency is the result of :

- Peculiar arrangement of corneal lamellae (lattice theory of Maurice)
- Avascularity
- Relative state of dehydration, which is maintained by barrier effects of epithelium and endothelium and the active bicarbonate pump of the endothelium.

CORNEAL EDEMA

The cells of the human corneal endothelium essentially do not undergo cell division after birth. However, corneal endothelial cells have a remarkable ability to enlarge and to maintain normal function in the face of cellular inadequacies or deficiencies, as are seen during the postnatal growth of the cornea, during normal cell loss in the aging process, and after cell loss caused by intraocular surgery and trauma. At birth, cell densities range from 3500 to 4000 cells/sq.mm, whereas the adult cornea normally has densities of 1400 to 2500 cells/sq.mm. Corneal transplants

may have fewer than 1000 cells/mm2 and remain clear. It would appear that as long as endothelial cells can enlarge to provide a confluent monolayer on Descemet's membrane, normal corneal function is maintained. A lower limit to this ability occurs at densities of 400 to 700 cells/sq.mm, below which endothelial function falters and corneal edema and loss of vision ensue.

The control of corneal hydration concerns itself with the normal healthy cornea with intact functioning membranes and avascular, compact corneal stroma. However, these normal properties are modified by disease and the reaction of the cornea can be complex. Although acute corneal edema, as can be seen in contact lens wear and in angle- closure glaucoma, is often reversible, chronic corneal edema is usually irreversible and treatment varies depending on the nature of the disorder. Chronic corneal edema develops as a consequence of endothelial dysfunction, regardless of whether the original clinical condition was dystrophy, inflammation, or trauma. The increased permeability or decreased ion transport function, or both, of this cellular layer leads to the subsequent corneal changes. In mild cases only, increased stromal thickness occurs with initially little consequence to vision. In advanced cases, epithelial edema ensues, which rapidly decreases.

GRADING OF CORNEAL EDEMA

- Mild - <3mm in diameter
- Moderate – 3-5 mm in diameter
- Severe - >5mm in diameter

VISUAL ACUITY IN CORNEAL EDEMA

Because of its surface smoothness and its transparency, the cornea normally allows a remarkably sharp image to be focused on the retina. In general these optical qualities can be reduced by opacities within the tissue (stroma or epithelium) or by surface irregularities, either in the form of gross astigmatism (e.g., keratoconus) or from minute central irregularities (e.g., bullous keratopathy and basement membrane dystrophy). As noted, normal stromal transparency can be explained by maintenance of average uniformity of its refractive index over distances of up to half the wavelength of light (approximately 2000 Å). In the normal corneal stroma, the collagen fibrils spaced some 600 Å from center to center are closer together than half the wavelength of light, explaining the optical qualities of the tissue. Transparency is still fairly well preserved in mild or moderate stromal edema, and backscattering toward the source is minimal. In more advanced and long- standing edema, however, irregular fluid accumulations occur in the stroma that can reduce transparency . Later

stromal scarring and posterior irregular astigmatism from folds in Descemet's membrane reduce visual acuity.

WOUND HEALING IN CORNEA

Because maintaining the continuity of the endothelial cell monolayer is critical to stromal deturgescence and hence optical clarity, endothelial repair processes after a variety of inflammatory and mechanical insults are of great clinical concern. Immediately after a posterior corneal wound, the cut edges of Descemet's membrane retract and curl anteriorly toward the stroma. Adjacent endothelial cells are lost, and a fibrin clot is formed in the wound. Within hours, adjoining endothelial cells attenuate with extensive cytoplasmic processes and migrate into the wound . In the adult human, virtually the entire healing effort occurs by means of cellular reorganization, enlargement, and migration to reconstitute an intact monolayer, despite the evidences for mitosis. After exposure to a variety of physical and chemical insults, the human corneal endothelium can repair itself either by limited mitotic division or by simple expansion and spreading of neighboring cells, or through an elaborate DNA repair system . Depending on the size of the wound, the entire defect can be re-covered within 1 or more weeks. Extracellular matrix glycoproteins , EGF, and actin appear to be important in regulating the growth and formation of the corneal endothelium *in vivo* . Once Descemet's membrane has been

resurfaced by a continuous endothelial monolayer, the cells become contact-inhibited and form contiguous cellular junctions. The cells that have been involved in the healing process are now much larger than those in uninvolved areas. Once the integrity of the endothelial cell layer has been restored, its pump and barrier functions soon begin to stabilize, as evidenced by stromal deturgescence, thinning, and increasing clarity. As part of the wound healing response, and indeed as a nonspecific response to any form of endothelial trauma, the regenerating endothelium deposits new layers of Descemet's membrane material . Where the wound is well apposed, a single endothelial layer appears and functions normally. Where there is poor wound apposition, endothelial cells are multilayered and undergo a fibroblastic transformation that results in posterior collagen layers comprising fibrillar banded collagen, basement membrane material, and fine filaments. In time, these cells also appear capable of reverting to a more normal endothelial morphology. However, the chronology of posterior wound healing is prolonged— months to years may be required for transformation into endothelium with new Descemet's membrane of normal morphology and thickness. As in other tissues, FGF and TGF-α1 have recently been described as key molecules able to modulate the endothelial response to wounds and promote an efficient endothelial healing .

RISK FACTORS

The existence of underlying predisposing anatomical factors can be considered especially in cases with bilateral involvement. Pre-existing poor endothelial counts as a significant risk factor has been put forth by Ti et al. The absence of corneal guttae pre-operatively gives an impression of healthy endothelium. Similarly, Kansal et al have suggested abnormal fibrillary stromal adhesion to Descemet's membrane as the possible cause. Genetic predisposition in the form of dysfunctional anchoring protein BIGH3 (due to mutation of TGF βI gene) has been postulated by Hirano et al. Although literature suggests various theories, the exact pathophysiology of delayed onset DMD still remains poorly understood due to lack of concrete evidence.

THE SIXTH CORNEAL LAYER - DUA'S LAYER

According to a 2013 paper by Harminder Singh Dua's group at the University of Nottingham, a hypothetical fourth caudal layer between corneal stroma and DM was suggested – the Dua's layer. Despite its thinness the layer is very strong and impervious to air.

Ex-vivo experiments were performed on human sclero-corneal discs not suitable for transplantation; that were maintained in organ culture medium and those dissected from "fresh" (within 24 hours of enucleation) donor whole globes. Air was injected in the deep stroma to simulate the

surgical DALK procedure. Air was noted to spread from the point of injection anteriorly, circumferentially and posteriorly to fill the corneal stroma and eventually result in the formation of a Big Bubble (BB). Three types of bubbles could be produced. A Type 1 bubble, which starts in the centre of the cornea by the coalescence of multiple smaller bubbles and expands centrifugally and posteriorly to assume a well circumscribed dome shaped appearance. It reaches a maximum diameter of $\leq$ 9 mm and maximum height (measured from epithelium) of 5.5 mm.

The DM could be completely peeled off a Type 1 BB without deflating the BB suggesting that the posterior wall of the Type 1 B, in addition to the DM is made of another distinct layer of tissue. This layer was termed the pre-Descemet's layer -Dua's layer (DL) . Equally it was possible to first peel off the DM from the sclero-corneal disc and then inject air to create a complete Type 1 BB indicating that the DM is not essential for the creation of a Type 1BB. With continued injection of air, a Type 1 BB (with DM peeled off) became tense but did not extend beyond a maximum of 9 mm diameter. This indicates that DL like the DM is impervious to air. This is an important characteristic of the DL as compared to the rest of the stroma where air moves in all directions. The tissue of DL presented as a glistening, pliable, resilient and tough layer . Tugging or pulling on the DL with a forceps after removing the DM

resulted in the formation of striae that could be seen extending from the tip of the forceps radially across the boundary of the BB to the limbus. This indicated that the DL extended to the limbus but the zone between the edge of the BB and the limbus was firmly attached to the underlying stroma. This attachment could not be broken either by injection of air or by attempts to mechanically and physically peel off the DL from the edge of the BB outwards. When DL from a Type 1 BB was excised along its circumference, further injection of air did not result in creation of another BB indicating that the DL is not a random separation of some posterior stromal lamellae of the corneal stroma.

Histological examination by light and electron microscopy confirmed that the posterior wall of a Type 1 BB is made of a collagenous layer of tissue (DL) and the DM and endothelium. Strands of collagen extend from the adjacent stroma into the DL. Strands of collagen bundles bridge the space between the DL and the stromal bed as demonstrated by both scanning and transmission electron microscopy . This explains the strands seen intra-operatively . Unlike the corneal stroma, DL that forms the posterior wall of a Type 1 BB did not demonstrate any keratocytes.

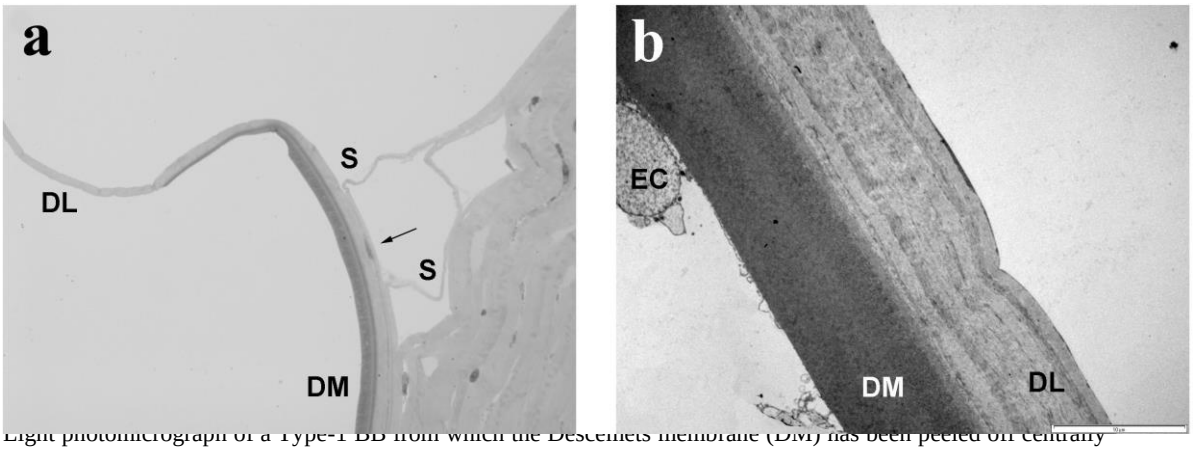
In summary,

- Evidence from the ex-vivo experiments on human donor eyes therefore suggest that following intra-stromal injection of air “DL”

separates no greater than 9 mm forming the type 1 bubble, which commences centrally by the accumulation and coalescence of several small bubbles and expands centrifugally.

- That DL extends to the periphery but is firmly adherent to the peripheral stroma, that it is impervious to air, that the DM can be peeled off the type 1 bubble without deflating it.
- That the presence of DM is not essential for the formation of a type 1 bubble, that mixed bubbles can occur and are not due to a split between banded and non-banded zones of the DM.
- That the DL that forms the wall of the type 1 bubble is devoid of keratocytes
- That it contains a fair amount of type VI collagen and long spacing collagen.
- That it is not a random separation of the posterior stroma leaving behind some “residual stroma” but a distinct layer that cannot be re-created by blowing out further “residual stroma” after excising the first one (the DL).
- That the diameter of the fibrils in the DL is significantly smaller than that of the posterior cornea.

This layer may help surgeon’s improve outcomes for patient’s undergoing corneal grafts and transplants.



a. Light photomicrograph of a Type-I BB from which the Descemets membrane (DM) has been peeled off centrally to reveal the Dua's layer (DL). Strands of collagen bundles (S) are seen extending from the stroma to DL. The separation occurs along the last row of keratocytes (arrow).**b.**Transmission electron micrograph: DL is made of multiple thin lamellae closely applied to Descemets membrane (DM). An endothelial cell (EC) is seen on the posterior surface of DM.

MANUAL SMALL INCISION CATARACT SURGERY

Manual small-incision cataract surgery (MSICS) was first described by Blumenthal in 1994 and it is known as the *Mini-Nuc Technique*. MSICS utilizes simple surgical instruments , a binocular operating microscope, ophthalmic viscosurgical devices, irrigation-aspiration systems and intraocular lenses . But it does not require access to other high-technology instrumentation, making it particularly useful in areas of the world in need of high-volume, low-cost cataract extraction.

Principles of the Mini-Nuc Technique

The procedure requires only a small incision and no stitches. It has proven to be safe surgery. It is possible to use topical anesthesia, and rehabilitation is speedy.

Moreover, it is cost-effective. There are some disadvantages, however, of manual ECCE. It is not an easy technique to learn and perform. There is a significant learning curve, and experience is required.

The proposed Mini-Nuc technique must be performed under positive intraocular pressure during all stages of surgery. The desired IOP is achieved during surgery with the use of an anterior chamber maintaining system, and controlled by the height of the BSS bottle.

Importance of Constant Irrigation and Positive 100% IOP

The principle of maintaining positive IOP during cataract surgery is gradually becoming acceptable to more surgeons, even those performing phacoemulsification. In the mini-nuc technique, positive IOP exists 100% of the operating time. Any fluid lost during intraoperative maneuvers is promptly recovered because of the large internal diameter of the ACM tubing . The steady flow ensures a constant depth of the anterior chamber. This flow continuously washes all debris: blood, pigment, and leftover cortical material from the eye with low turbulence and low fluctuation of anterior chamber depth. Consequently, less postoperative inflammatory reaction occurs. There is significant interest about these The BSS bottle can be used as a *reservoir of pharmacological drugs* to be infused continuously into the eye. These drugs may include adrenaline 1:1,000,000, to keep the pupil dilated, antibiotics, and any other drug the

surgeon wishes to use. The length of surgery is not critical as the constant positive IOP keeps the aqueous blood barrier intact; and the ciliary processes and choroidal, retinal, and iris vessels are not exposed to a hypotonic environment at any time. This helps to prevent exudate formation or a worse complication, expulsive hemorrhage.

Blumenthal considers that positive IOP provides not only a safe milieu and prevents complications; it is a precondition for controlled surgery. Because the internal architecture of the eye is not disturbed, planned maneuvers can be carried out safely.

SURGICAL TECHNIQUE

Anesthesia, Paracentesis, ACM

Lidocaine 4% drops are instilled 15 minutes before surgery 3-4 times. At present Esrecain gel is used with each Lidocaine drop. A total of 0.2-0.3 cc of Marcaine 0.5% with adrenaline is injected subconjunctivally between 11:00 and 2:00 in the limbal area, where diathermy will be applied. During surgery, 0.2-0.3 cc of intraocular non-preserved Lidocaine is injected into the tube of the ACM. It will reach the eye in diluted form. This is very efficient, cost-effective ocular anesthesia. Two paracenteses are performed at 10:30 and 2:30 by stiletto knife . Moderate beveled incisions are made in clear cornea just at the edge of the blood vessels. The same stiletto knife is used for an incision just anterior to the limbus in the

clear cornea for the purpose of inducing the ACM cannula (5149 oval Visitec) in the 6 o'clock area .

Paracentesis Incision and Fixation of ACM

The most important aspect of the beveled tunnel paracentesis incision to introduce the ACM is its length. The incision should be at least 2 mm long before the knife penetrates the AC, and will be 1 mm wide .

The ACM is introduced into the tunnelshaped paracentesis, beveled edge up. When it reaches the AC, it is turned beveled edge down, and the ACM flow is directed towards the iris. The ACM is introduced 2.0 - 2.5 mm into the AC, and not more. The shallower the depth of the AC, the greater care the surgeon should take not to exceed these limits.

Height of BSS Bottle

Normally, the BSS bottle should be located 40 to 50 cm above the eye, keeping the IOP at 30-40 mm Hg. If intraocular bleeding occurs, raising the bottle will stop the bleeding. If a posterior capsule tear occurs, the bottle should be lowered to 20 cm. The BSS bottle should be lowered even further to 10-15 cm when suturing, in order to achieve the best adaptation of the incision edges. The most important concept to keep in mind is that the height of the BSS bottle can be changed depending upon the situation. It does not need to be standardized, and the surgeon can

adjust it according to his/her own technique, and varying needs during surgery.

Capsulorhexis

The ACM and positive IOP push the crystalline lens backward reducing the force of the zonules exerting pressure on the anterior capsule toward the periphery. This facilitates capsulorhexis performed by a cystotome, and avoids unintended tears toward the periphery of the crystalline lens. Forceps introduced through the paracentesis corneal tunnel produce outflow of BSS thus reducing the AC depth and causing the zonules to pull the anterior capsule more forcefully.

Blumenthal believes that although capsulorhexis can be done successfully using forceps with viscoelastic material or even BSS only, positive IOP in the anterior chamber provides the best precondition for successful and controlled capsulorhexis performed through the paracentesis using a cystotome.

Conjunctiva

A conjunctival flap is cut 1 mm from the limbus between 11:00 and 2:00. The 1 mm of conjunctiva attached to the limbus facilitates the postoperative healing process. Healing of conjunctiva to conjunctiva occurs quickly and is stable, unlike the healing process between

conjunctiva and limbus. The attached conjunctiva also makes it possible to glue the edges of the conjunctiva by coagulation.

Sclerocorneal Pocket Primary Incision and Tunnel

Precondition for Utmost Controlled Dissection

The main reason the ACM is introduced at the beginning of surgery is to keep the IOP between 30 and 40 mm Hg to make the eye coats taut. The importance of this precondition for the utmost controlled dissection in the sclera and cornea should not be underestimated. Most unintended misdirected scleral dissection, premature entrance to the anterior chamber, or failure to achieve a full-size scleral pocket tunnel occur as complications of dissection in soft, floppy tissue.

The sclerocorneal tunnel architecture of the primary incision which Blumenthal prefers for manual ECCE begins with an external straight scleral incision 4 to 6 mm long and 0.3 mm deep . It should be performed 1 mm behind the limbus at the surgeon’s choice of location, either 12:00 or temporal. As the external incision is cut straight, the distance of this incision varies gradually from the limbus. It is 1 mm behind the limbus at 12:00, while on both sides the external incision is further away form the curved limbus, up to 1.5 mm to 2 mm.

At the bottom of the 0.3 mm deep external cut, dissection is extended anteriorly until it engages the limbal tissues, which resist

dissection more than scleral or corneal tissues. In overcoming this extra resistance, the surgeon must take care not to press forward too forcefully, which might cause uncontrolled forward corneal dissection and premature perforation of the AC. Control of lamellar dissection at all stages is critical. Dissection continues forward for about 2 mm in clear cornea. As the dissection approaches the lateral edge of the tunnel, the knife is swept sideways 45 degrees, resulting in a funnel-shaped tunnel . Thus the internal aspect of the tunnel is about 25% larger than the external incision. While the crescent knife is at the lateral edge of the straight external part of the incision, dissection should be carried obliquely backward. In this way the crescent knife forms a lateral pocket on both sides extending backward for 1 mm on each side. A *backward* incision 90 degrees to the limbus such as hereby described, does not induce astigmatic effect. With practice the result should be a well-constructed pocket sclerocorneal tunnel .

Now the keratome is slid into the tunnel with a slight side to side movement to prevent premature perforation of the anterior chamber. When the tip of the keratome reaches the end of the tunnel, the keratome is then tilted downward to enter the anterior chamber. After entering the anterior chamber, the keratome is moved laterally and forward. This combination of movements directs the internal incision in curved fashion parallel to the limbus. The procedure is repeated on the other edge of the tunnel. Thus the

extreme edges of the internal incision (temporal and nasal points of entry of the AC), are 3.5 to 4.0 mm from the lateral points of the external incision. A common error in constructing this tunnel occurs when the keratome, instead of moving laterally and *anteriorly*, is directed laterally and backward, thereby creating a much smaller tunnel. The more funnel shaped the tunnel is, the less astigmatism induced, and the less potential there is for BSS leakage from the AC either during or after surgery. All these movements are performed while the eye is fixated with Bonn forceps, away from the tunnel incision.

Hydrodissection and Nucleus Dislocation

Hydrodissection is performed through one of the two paracenteses located at 10:30 and 2:30 . Professor Blumenthal uses a 1 cc syringe attached to a cannula. A 3-5 cc syringe should not be used, as a sudden surplus of BSS in the crystalline lens might burst the posterior capsule. The cannula should be introduced under the anterior capsule at the 12:00 position. No more than 0.1 cc to 0.3 cc of BSS is injected, engulfing the lens contents instantly by hydrodissection. In most cases the nucleus tilts forward into the AC at the 12:00 position, as the BSS fluid accumulates first at this location . In cases where the nucleus is not partially dislocated anteriorly, one or two Sinskey hooks are introduced at one or both paracenteses located at 11:00 and 2:00. Uneven pressure by one hook

while the nucleus is rotated causes the nucleus to tilt and gradually to dislocate anteriorly. The surgeon should make sure that the nucleus tilts up toward the wound. If it does not, the lens should be rotated further until this alignment is achieved. When the tilt is not sufficient in the surgeon's judgment, the bent part of a cannula should be introduced under the lens while BSS is injected. This will cause the nucleus to move gradually anteriorly completely into the AC. The use of too much force during this maneuver can cause the lens to suddenly touch the endothelium.

Blumenthal does not remove cortex at the center of the lens anteriorly because this cortex protects the endothelium from the rough nucleus during movements in the AC. The lens does not need to be completely dislocated to the AC before extraction can begin. When the nucleus is free after rotation, it can remain partially in the bag and partially in the AC .

Nucleus Expression Using Glide and High IOP

Before the lens glide is introduced under the nucleus, the surgeon must first assess whether viscoelastic material is needed in addition to the ACM. Blumenthal considers using viscoelastic in shallow chambers and in patients with glaucoma that may have a small pupil. The glide should not be induced forcefully as it might engage the nucleus itself rather than slide under it . The glide should not move too far inferiorly or it may tear the

posterior capsule. If a glide is not used, the nucleus may not move in a controlled way towards the incision.

To move the nucleus (with its epinucleus) into the wound, slight external pressure should be exerted with a closed forceps or other instrument on the glide inside the tunnel in a stroking pattern. The strokes may need to be repeated a few times until the nucleus is pushed forward by fluid from the ACM to engage the mouth of the sclerocorneal tunnel . At first, BSS still leaks around both sides of the nucleus. Stroking is continued until the nucleus is well lodged in the inner aspect of the sclerocorneal pocket, and no leakage is observed. Continued pressure should not be made in the tunnel when the nucleus is engaged, as pressure in the tunnel would open the tunnel and new leakage would begin, preventing nucleus expression.

Now pressure is shifted out of the tunnel, posteriorly, onto the sclera. This slightly changes the position of the nucleus in the tunnel to allow expression. The nucleus rocks from side to side, and rotates slightly on its axis while finding its way out of the tunnel .

The amount of pressure to induce can be assessed by observing the depth of the AC, which should not change. If the AC collapses, stop pressing and allow it to reform. The preceding description is accurate when the tunnel is large enough to allow the nucleus to pass through the tunnel.

During this move, it sheds any remnants of epinuclear material; in this way the smallest possible nucleus is delivered. The remnants of the epinucleus are observed as leftover in the AC; they are soft and easily expressed by the hydrostatic pressure itself . Their progress is helped by gentle strokes in the tunnel, causing BSS to flow out of the eye. The BSS on its way out engulfs the soft epinucleus and flushes the epinucleus out. Should the nucleus proper be too large to be expressed, the surgeon has two choices:

(1) Enlarge the inside aspect of the tunnel, not the external incision; or

(2) Perform chipping.

Part of the nucleus is exposed in the incision. A 25 gauge needle is introduced into the nucleus, chipping off a small triangular piece. The smallest new diameter of the nucleus can be made small enough for the nucleus to be expressed.

Epinucleus and Cortex Extraction

Epinucleus

Continuous flow and positive IOP inflate the capsular bag after nucleus extraction.

The soft epinucleus left behind in the AC is usually hydroexpressed spontaneously. To facilitate this maneuver a spatula can be introduced through the tunnel . In cases where the epinucleus is left in the capsular

bag, manipulation in the bag right and left by the spatula will release the epinucleus from its adherence to the cortex and allow it to be flushed out.

The Cortex

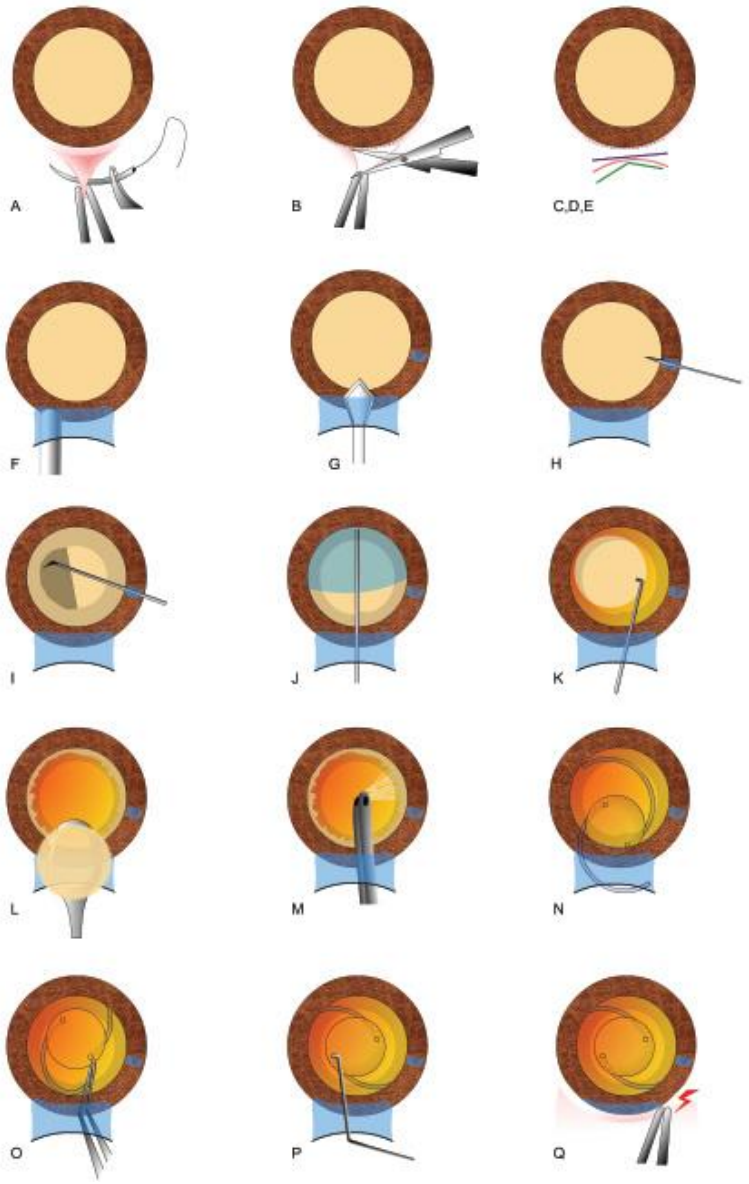
Blumenthal recommends aspirating the cortex manually; aspiration is better controlled using a 5 cc syringe and cannula . The cannula should be introduced from one of the paracentesis sites and not from the tunnel because introducing a cannula through the tunnel may allow BSS to escape. The resulting instability of the posterior capsule would be unfavorable for smooth aspiration of the cortex. Using the paracentesis port for aspiration allows the amount of BSS aspirated or lost to be instantaneously replaced by the anterior chamber maintainer.

IOL Implantation

The leading haptic is inserted into the AC and under the anterior capsule at 6:00 o'clock . The anterior chamber may become shallow for a short period during this maneuver. For this reason a strong IOL holder is recommended so that the leading loop can be directed under the capsule even in the presence of a shallow AC. When the leading loop is stable under the capsule, the IOL holder is released, but not before forceps grasp the trailing loop outside the eye to prevent the IOL from springing out of the bag at 6:00. A modified Sinskey hook is inserted

through one of the paracenteses, usually at 10:00 for right-handed surgeons and the lens is manipulated into the bag. The trailing loop is introduced into the AC first. Then the IOL is rotated while pushing backward . Thus the trailed loop enters the bag . Blumenthal prefers to have holes in the loops and one hole in the haptic near the optic for manipulating the lens into the capsular bag. Blumenthal has seen no ill effects resulting from haptic holes.

Studies have shown that, in comparison to ECCE, MSICS allows a higher surgical volume and faster visual recovery and it results in less postoperative astigmatism and better uncorrected visual acuity (also called uncorrected distance visual acuity). Visual outcomes and complication rates for MSICS are similar to those for phacoemulsification performed in the developing world.



Surgical steps of manual small incision cataract surgery (SICS):

A Superior rectus bridle suture
B Conjunctival flap and exposure of sclera
C, D & E External Scleral incisions (straight, frown shaped, and chevron,respectively) part of tunnel incision
F Sclero-corneal tunnel with crescent knife
G Internal corneal incision
H Side port entry
I Large CCC
J Hydrodissection
K Prolapse of nucleus into anterior chamber
L Nucleus delivery with irrigating wire vectis
M Aspiration of cortex
N Insertion of inferior haptic of posterior chamber IOL
O Insertion of superior haptic of PCIOL
P Dialing of the IOL,
Q Reposition and anchoring of conjunctival flap.

DESCEMET'S MEMBRANE DETACHMENT

It has been suggested that some eyes possess an anatomic predisposition for detachment of DM. This view is supported by the occurrence of this complication to a major or minor degree in both eyes of patients undergoing intraocular surgery. The cause is probably a mechanical one related to faulty instrumentation or technique. A dull knife, keratome, scissors, anterior chamber irrigator , phacoemulsification or irrigation-aspiration handpiece are likely causes, **but in these eyes there is an added possibility of an inherent predisposition.** One or more of the variety of solutions (BSS, OVDs, etc) irrigated into the eye may also be responsible. The possibility of this occurring during surgery is increased if difficulties are encountered. For example , in glaucomatous eyes with shallow anterior chamber or anterior synechiae , DM may be detached when incision is made. Scissors enlargement of incision is not an infrequent cause. This problem may also occur in phacoemulsification or in a planned Extra capsular cataract extraction , in a closed system, during an anterior capsulectomy, during emulsification or aspiration parts of the procedure. One must be particularly careful not to mistake a tag of stripped DM for a tag of anterior capsule. Otherwise it may be pulled out of the eye. DM may be stripped during the introduction of an intraocular lens into

the eye. This can be prevented by allowing the cornea to enfold and not lifting the cornea during this maneuver.

Descemet's membrane detachment (DMD) or tears may occur as a complication of intraocular procedures. It was first reported in 1927 by Weve. Surgical trauma is the predisposing factor in DMD and is reported after cataract surgery, viscocanalostomy, trabeculectomy, iridectomy, penetrating keratoplasty and cyclodialysis. It is most commonly encountered during cataract surgery and diagnosis is made intra-operatively in 50 % of the cases . Rarely, it can develop late in the post – op period varying from weeks to months . Clinical presentation is that of decreased vision associated with corneal edema. If left untreated, edema may persist, leading to corneal decompensation and vision loss. DMD may manifest with loss of vision due to corneal edema and the presence of Descemet's membrane (DM) folds. The incidence of DMD has been reported from 2% to 6% and from 0% to 5% during extracapsular and phacoemulsification catatact surgery, respectively.

Detachment of DM to a minor degree is not rare. These detachments look like small transparent tags curling inward from the corneal lip of the incision. Monroe examined 120 eyes gonioscopically after cataract extraction and found scrolls of detached DM in 11% and focal detachment of ragged edge of third layer in 43%, with the absence of clinically

significant sequelae. Histologic study of 8 or 9 eyes after cataract extraction by Flaxel showed fragmentation and dislocation of DM near the wound edge. These defects are usually of little consequence because the endothelium covers them and slowly secretes a thin new DM.

RISK FACTORS

- Inadvertent insertion of instruments between the corneal stroma and Descemet's membrane.
- Improper incisions (excessively anterior or shelved incisions).
- Too tight or too long corneal tunnels
- Shallow anterior chamber
- Use of blunt keratomes
- Inadvertant injection of saline or ophthalmic viscosurgical device in the space between stroma and DM.
- Genetically related weak adhesions between stroma and DM.
- Preoperative glaucoma
- Recent onset of corneal edema
- Alpha-chymotrypsin
- Engagement of Descemet's membrane during intraocular lens implantation .
- Misuse of the irrigation/aspiration devices

However, owing to improved instrumentation and techniques, this complication occurs less frequently.

MECHANISM OF DMD

The mechanism of stripping of Descemet's membrane is obscure. Weve speculated that it can been cut by a cystotome allowing the edges to retract and roll away from the cornea. The stripping might have also been caused by the sweep of an iris spatula or an irrigator that had been inserted beneath Descemet's membrane accidentally. This could explain the sharp delineation of the detachment. Conceivably a scissors used to enlarge the section could cause the same accident, or even a capsule forceps.

Studies explored the possibility of an underlying anatomic predisposition for the development of DMD, possibly explained by an abnormality in the fibrillary stromal adhesion to DM. Some patients may have an abnormal attachment between the stroma and DM caused by dysfunction of the anchoring protein βig-h3 as postulated by Hirano at al. Although literature suggests various theories, the exact pathophysiology of delayed onset DMD still remains poorly understood due to lack of concrete evidence.

DIAGNOSIS

Ultrasound biomicroscopy, optical coherence tomography and Schiempflug imaging provide quantitative information and qualitative

imaging of the cornea and anterior chamber. Pachymetry can be used to assess the Central Corneal Thickness (CCT).

The height and length (chord length) of the DMD can be measured in millimeters using Ultrasound biomicroscopy (UBM). The extent of involvement in various zones of cornea will be evaluated clinically using slit-lamp biomicroscopy with undilated pupils.

COMPLICATIONS OF DMD

Detachment of DM may lead to more serious consequences by contributing to fibrous ingrowth. Bettman found this problem in 22% of adults and 105 of congenital cataract extractions in his series of 122 enucleated eyes after all kinds of intraocular surgery. Of 30 eyes, 18 (60%) with fibrous ingrowth had detached fragments of DM, whereas only 5 of 92 eyes (5.4%) without fibrous ingrowth had such outcome. The portion of denuded cornea of DM becomes edematous and opaque. If the detachment is extensive, edema may progress to bullous keratopathy, undoubtedly the result of exposure of the unprotected corneal stroma to aqueous. The cornea in this region becomes thicker than elsewhere. Usually a sharp line demarcates a clear and edematous cornea. This line may be highlighted by a deposit of pigments in the trough formed by the detachment. In other cases, edema is diffuse, and one has difficulty in determining the extent of detachment without slitlamp and without first

reducing the edema with a topically administered hyperosmotic agent. Hecht reported an interesting method of estimating the extent of planar DM detachment. After clearing the cornea with anhydrous glycerin 10ml of 10% flurescein solution is given intravenously. During the subsequent 60 minutes the anterior chamber is observed. As the dye fills the anterior chamber , the patient's face may be directed downward at any angle. The dye is thus able to concentrate behind DM , thereby outlining its posterior surface. The detached portion of DM may curl back into place , and the edema may subside. It may however permanently adhere to the iris. In addition, iris may adhere to the denuded potion of the cornea in the form of anterior synechiae; this complaint is often associated with cellular infiltration of posterior cornea and fibrous proliferation. A large area of denuded corneal stroma may be covered by newly regenerated DM. Occasionally DM may not curl inwards as sheet but may be detached from the stroma over a wide area , with only a narrow space between the two layers. In one such case , Sparks observed that DM was detached from the posterior stroma by what looked like a distance of not more than 0.5mm and showed no tendency to curl up. The detachment originated from a site near the limbus where a tiny hole could be seen in the membrane through which aqueous was obviously gaining access to corneal stroma.

Because DM is not digested by the autolytic processes of the body, it remains undisturbed indefinitely in ectopic locations or abnormal configurations. Changes that occur in childhood are often observed during an examination later in life.

DIAGNOSIS

Usually cataract surgery is uneventful, but occasionally some difficulty is encountered in the enlargement of the incision. the surgeon may observe the DM detachment when making the incision. Corneal edema is present early and is usually mistaken for excessive DM folds. If the cornea is cleared with glycerin or any hyperosmotic agent, the diagnosis is usually made with the aid of slitlamp. A sheet of DM curled inward or the detection of separation of membrane from the posterior stroma confined to the area of corneal edema is diagnostic.

If the condition remains undiagnosed for sometime, a number of problems in differential diagnosis could appear. These include the following postoperative conditions that cause a localized corneal edema restricted to the upper half of the cornea.

1. Epithelial downgrowth
2. Fibrous ingrowth
3. Vitreocorneal adherence
4. Malapproximation of surgical wound

5. Shelved corneal incision

The first two complaints are rarely present early; the third and fourth are diagnose during slitlamp examination, and the fourth tends to show progressive clearing as healing proceeds. Generally , the diagnosis of detachment of DM is not difficult to make, and its differential diagnosis is rather simple.

PROGNOSIS

According to most reports, the prognosis for visual improvement is poor. Most minor detachments of DM cause no difficulty. The cornea overlying it may remain opaque or edematous, but this condition remains confined to the area of detachment. When the detachment covers over a wide area , the prognosis may be unfavourable, as emphasized by Scheie. The condition may deteriorate rapidly from corneal edema to painful bullous keratopathy. In all three of Scheie's cases and in the two reported by Weve, persistent corneal edema and bullous keratopathy resulted. Although this is the usual outcome, the final result may be more favourable. Sugar reported three cases of extensive detachment, two of which cleared spontaneously and the third requiring surgical correction. Thoedore and Norman S Jaffe added another each that had favourable outcome without surgical correction.

TREATMENT

Surgical correction of the detachment offers the only hope for a cure if the condition of the eye appears to be deteriorating. DM must be uncurled and kept in this position so that the corneal stroma is protected from aqueous. Sparks used a simple technique that favourably influenced three cases. When DM is curled inward, a limbal stab wound is made and the aqueous is removed. The anterior chamber is filled with air. The curled up membrane is then manipulated back into place with cyclodialysis spatula. When DM is separated from the stroma but not curled inward, filling the anterior chamber with air or a viscoelastic material may be sufficient to create reattachment.

Because the patient may show an anatomic predisposition to detachment of DM, when the condition arises in one eye it should be anticipated in the other. A deep sclera section in the second eye may prevent it. Because the DM ends more peripherally than is usually anticipated at surgery, the incision should be made at least 2mm posterior to the limbus. In addition, such an incision need not be made morethan 150 degrees in extent. If DM curls inward when the incision is made , a viscoelastic material or air is introduced into the anterior chamber and one can suture the stripped edge to the cornea using 10-0 nylon or polypropylene swaged onto a fine needle. If this approach is

successful, surgery can be continued. Otherwise the incision should be closed and the anterior chamber filled with air. Surgery may be performed later using a more posterior incision or a new incision site. If the diagnosis is made after surgery, Sugar suggested reopening the central portion of the wound and unrolling the scroll of DM with an iris repository. The edge of the membrane is then sutured to the cornea with a single suture. Air is placed in the anterior chamber, and the wound is resutured. This treatment was applied in one case with an excellent result.

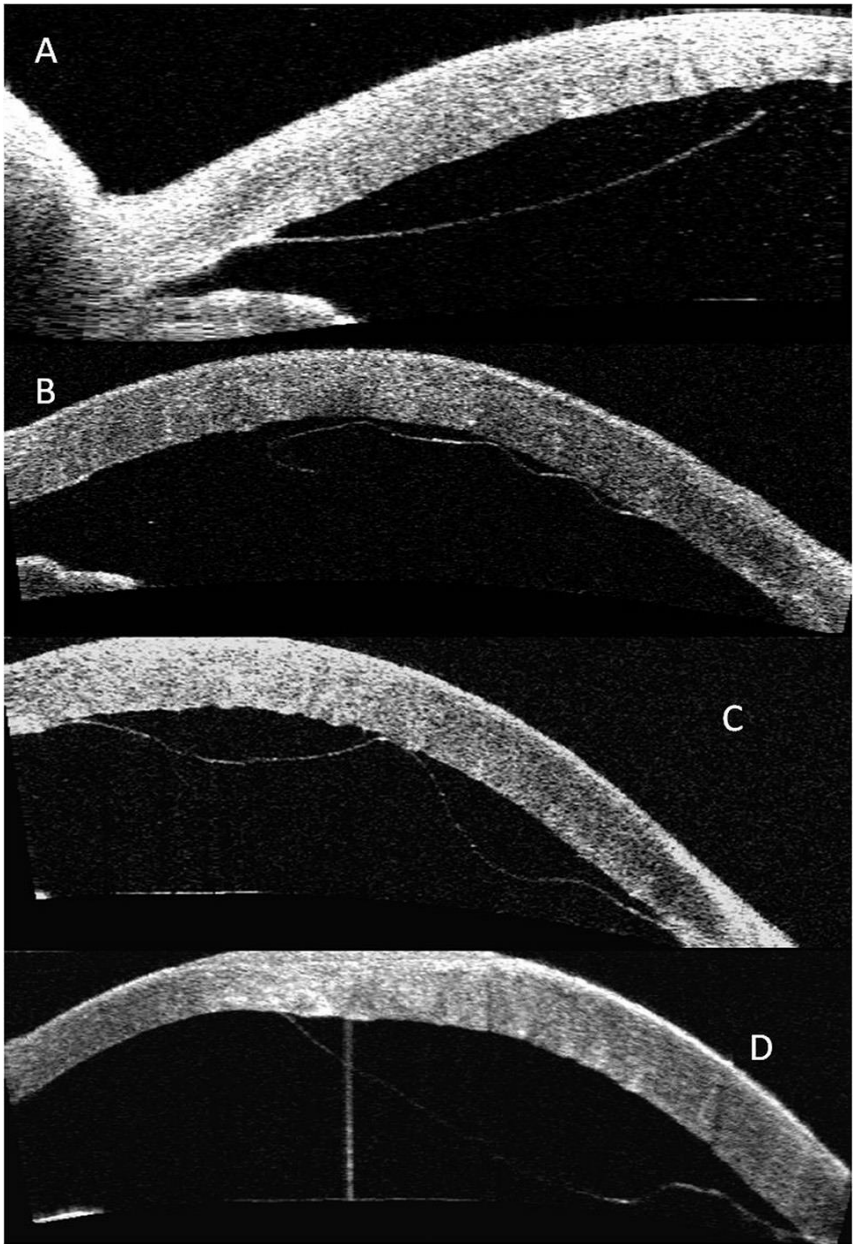
In some cases, it is possible to suture the detached edge of DM to the area of surgical incision. The membrane is unfurled with air or viscoelastic material. A 10-0 nylon or polypropylene suture is passed through the cornea about 1.5mm inside the limbus, through the margin of DM, and out through the sclera 1.5mm outside the limbus. The suture is tied and left in situ. Additional suture bites may be taken.

If these simple methods fail, a penetrating keratoplasty should be performed. We have a relatively large graft in these cases (8.5mm donor; 8mm recipient). The results are usually good.

DMD CLASSIFICATIONS

- BASED ON THE ZONES INVOLVED
    - ZONE 1 - central 5.0mm

    - ZONE 2 – paracentral, 5.0 to 8.0mm
    - ZONE 3 – periphery, > 8.0mm
- BASED ON MORPHOLOGY (by Mackool and Holtz)
    - Planar – less than 1mm gap between DM and stroma
    - Nonplanar – more than 1mm gap between DM and stroma
- BASED ON THE APPEARANCE OF THEIR EDGES
    - Scrolled – with rolled out edges
    - Unscrolled – with linear edges
- GRADING OF SEVERITY OF DMD
    - Mild – peripheral ; involing 25% of cornea
    - Moderate – peripheral ; involving 25 -50% of cornea
    - Severe – central ; involving >50% of cornea



A: Descemet membrane detachment with linear edge.
B: Descemet membrane detachment with wavy pattern with scroll.
C: Descemet membrane detachment with wavy pattern without scroll.
D: Deep bullous Descemet membrane detachment.

NEW CLASSIFICATION

Amar Agarwal, Soosan Jacob et al proposed a new classification of Descemet's membrane detachment based on clinico-morphological, etiological, tomographic and intraoperative features, as well as a new treatment algorithm for Descemet's membrane detachment based on its classification. With newer surgeries such as Descemet's membrane endothelial keratoplasty (DMEK) gaining acceptance, and a distinct layer of the cornea known as Dua's layer being recognized, there is a need to focus in greater detail on Descemet's membrane detachments.

This classification is analogous to the classification of retinal detachment; the Descemet's membrane is a vital layer of the cornea and is necessary for maintaining the clarity of the cornea, just as the neurosensory retina is required for visual perception. Just as a retinal detachment can be classified as rhegmatogenous (secondary to hole, tear or dialysis), tractional or bullous/exudative, Descemet's membrane detachment can also be classified as:

- rhegmatogenous,
- tractional
- bullous
- complex .

A rhegmatogenous Descemet's detachment generally occurs as an intraoperative event when there is a break in the Descemet's membrane, with fluid accumulation between the Descemet's membrane and overlying stroma. Analogous to a rhegmatogenous retinal detachment, a rhegmatogenous Descemet's detachment can be secondary to a hole (eg, a double anterior chamber following perforation during deep anterior lamellar keratoplasty) or a tear (eg, a detachment that occurs during insertion of blunt instruments or IOL implantation during phacoemulsification). Rhegmatogenous detachments can also occur secondary to a dialysis of the Descemet's membrane from its attachment at the Schwalbe's line — a complication that is sometimes seen during trabeculotomy, punch insertion in trabeculectomy, anterior chamber maintainer insertion, or if stripping of the Descemet's membrane accidentally extends toward the periphery during DMEK.

The Descemet's membrane may also become detached secondary to an inflammatory or fibrotic process, resulting in a tractional detachment. This could occur secondary to incarceration of the Descemet's membrane in an inflammatory process (eg, in peripheral anterior synechiae or within the graft host junction in large diameter grafts) or to incarceration in a wound or suture with subsequent contraction. A long-standing rhegmatogenous Descemet's detachment could also sometimes adhere to

intraocular contents with secondary fibrosis, thus turning into a tractional Descemet's detachment.

A bullous Descemet's detachment can occur secondary to a disease process, such as posterior corneal abscess, tumor, infection or inflammation, similar to bullous/exudative retinal detachment. With this type of detachment, a separation and convex bulging of the Descemet's membrane into the anterior chamber occurs in the absence of a break in the Descemet's membrane. The space in between the stroma and the Descemet's membrane is filled with pus, exudates, fluid, viscoelastic or air, depending on the cause of the detachment. This configuration of Descemet's membrane can also be seen as part of the Anwar's big bubble technique in deep anterior lamellar keratoplasty, which detaches the Descemet's membrane from the stroma and sometimes occurs from accidental injection of viscoelastic into the pre- Descemetic space.

A complex Descemet's detachment shows complex folds or scrolls, or a combination of other features, and can sometimes occur as the result of a poorly attached DMEK graft.

THE AS-OCT FEATURES

In all cases of Descemet's membrane detachment, there is generally overlying corneal epithelial and stromal edema, which may make visualization difficult. In this case, the anterior segment optical coherence

tomography is useful for diagnosis, as well as for differentiating between various types of Descemet's membrane detachment.

A rhegmatogenous Descemet's detachment is usually seen as an undulating, linear, hyperreflective signal in the anterior chamber. It may also be scrolled or crumpled, depending on the extent of detachment. It has folds and is mobile, similar to a rhegmatogenous retinal detachment.

On the other hand, a tractional detachment is seen as a straight, taut linear signal between two points of attachment (Figure 2). It has no folds and is not mobile.

With a tractional Descemet's detachment, the arc length of the cornea is more than the length of the detached Descemet's membrane, unlike with a rhegmatogenous detachment, where the arc length of the overlying corneal stroma is similar to the length of the detached Descemet's membrane.

A bullous Descemet's detachment is seen as a curved, hyper-reflective signal bulging into the anterior chamber from the overlying stroma, and a complex Descemet's detachment shows complex configurations on anterior segment OCT.

RELAXING DESCEMETOTOMY

The term "descemetotomy" was first used by Lowenstein in 1993 in reference to a procedure where the Nd:YAG laser was used in the

postoperative period to create communication between the anterior chamber and the supernumerary chamber after intentionally retaining the Descemet's membrane during keratoplasty for bullous keratopathy. Steinemann et al and Masket et al also used the Nd:YAG laser to create a central opening in inadvertently retained opacified host Descemet's membrane after penetrating keratoplasty.

Previously, the authors used the term "iatrogenic descemetorrhexis" for a case where accidental descemetorrhexis occurred in a patient during phacoemulsification. A similar case was also reported by Pan and Au Eong. Descemetorrhexis has been described as part of endothelial keratoplasty procedures where the central Descemet's membrane is intentionally removed from the host cornea.

The term "relaxing descemetotomy," which the authors have coined, differs from the aforementioned terms in that it describes a therapeutic procedure that relieves the traction forces and decreases foreshortening of the Descemet's membrane in a procedure similar to that of a relaxing retinotomy. The relaxing descemetotomy incisions break the stress forces acting on the Descemet's membrane. The tautness of the Descemet's membrane is relieved, and an air or gas bubble is used to appose the now lax Descemet's membrane against the overlying corneal stroma. A nonexpansile concentration of a long-acting gas, such as C3F8 or SF6, may

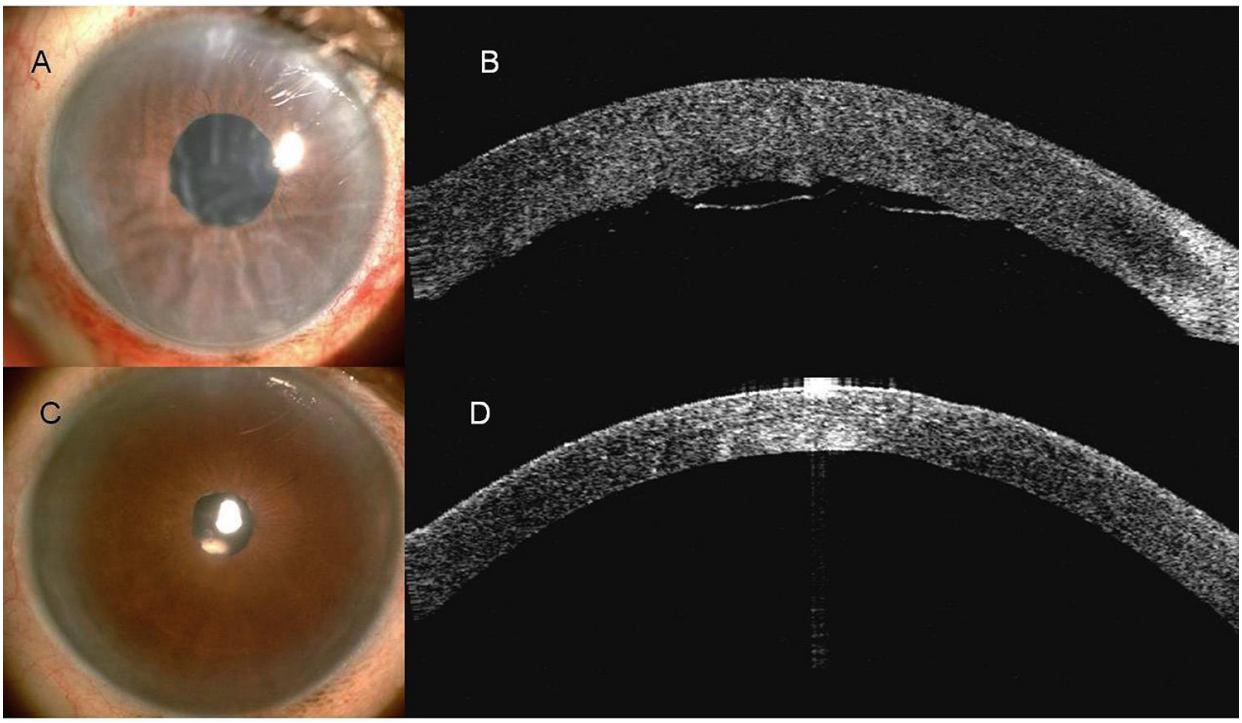
be used to provide a longer period of tamponade, such as is sometimes preferred in more severe and complex cases of rhegmatogenous Descemet's detachment.

CLASSIFICATION BASED TREATMENT

Treatment for each of the Descemet's detachment classifications varies. Although both rhegmatogenous and tractional Descemet's detachment require internal gas tamponade or pneumodescemetopexy and internal/external (via corneal stab incisions) sub-Descemet's fluid drainage, tractional Descemet's detachment also requires relief or removal of the element of traction for the Descemet's membrane to settle onto the stroma. This can be done by performing relaxing descemetotomy incisions. Relaxing descemetotomy may be performed with the anterior chamber filled with viscoelastic or air. The tip of a 26-gauge needle is bent in the reverse direction, as in a capsulotomy needle, and is introduced into the anterior chamber to make the relaxing descemetotomy incisions . The extent of the incision is determined during surgery by assessing the degree of foreshortening that still remains. If foreshortening is not completely relieved, the incisions are further extended until the Descemet's membrane is able to lie fully apposed against the stroma. These incisions are made in the peripheral cornea avoiding the pupillary plane and the visual axis.

In the presence of synechiae causing tractional Descemet's detachment, synechiolysis and membrane peeling may also be required to remove tractional fibrotic bands pulling on the Descemet's membrane. Sub-Descemet's fluid drainage is carried out by injecting gas from the side opposite to the tear or, in some cases, by making a small stab incision in the cornea overlying the Descemet's membrane detachment to drain the fluid externally.

Postoperative tamponade with nonexpansile concentration of C3F8 (14%) or SF6 (12%) is administered with face-up positioning of the patient for 1 hour. A reattachment may not occur in all cases, depending on the extent of inflammatory fibrotic damage to the endothelium, in which case the patient may require a posterior lamellar or full-thickness graft. The decision for relaxing descemetotomy is made based on clinical significance of the tractional Descemet's detachment and the presence of functional endothelium. Clinically insignificant, asymptomatic detachments may be left alone, whereas in case of dysfunctional endothelium, endothelial keratoplasty is preferred.



Clinical photograph and AS-OCT showing the spontaneous reattachment of Descemet membrane and resolution of corneal edema . Before resolution (A and B) and after resolution (C and D) of Descemet membrane Detachment .

THE SURGICAL TECHNIQUE

Air Bubble Tamponade or Pneumodescemetopexy

Under topical/peribulbar anesthesia , Descemet's membrane can be reattached . The anterior chamber entered with a MVR blade at the far peripheral cornea close to the limbus, distal to the area of Descemet's membrane detachment, and a 30-gauge blunt cannula introduced into the anterior chamber . The cannula tip advanced toward the central cornea close to the pupil . Air will be steadily injected into the anterior chamber to attain a large air bubble, thus re-attaching the detached Descemet's membrane . Folds in the attached Descemet's membrane will be clearly visible in the central cornea. A muscle hook used to gently massage the central corneal dome. The muscle hook be moved in various radial directions from the central to the peripheral cornea, applying gentle pressure on the external corneal dome, to iron out any folds and attain a uniform Descemet's membrane attachment to the patient's inner corneal stromal surface. This results in the uniform attachment of the Descemet's membrane without any folds or gaps.

The air bubble be further enlarged to fully fill the anterior chamber , resulting in a temporary increase in IOP. This large air bubble to be left in place for 3 minutes to allow uniform attachment of the detached Descemet's membrane. After 3 minutes, the cannula will be reintroduced

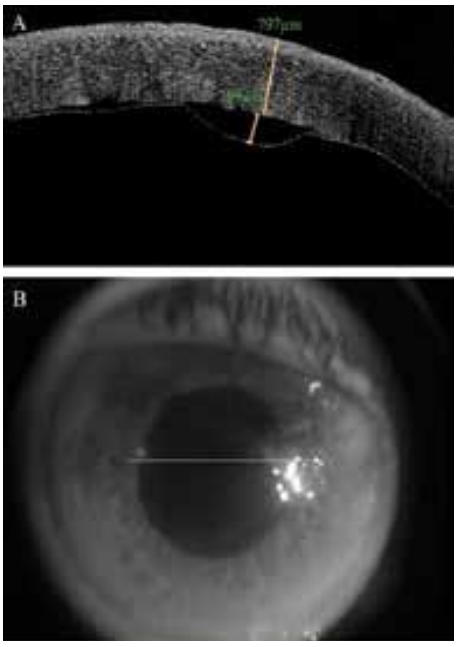
into the central region of the anterior chamber, and the air bubble size decreased. No peripheral iridectomy shall be performed, so it is imperative to reduce the size of the residual air bubble within the anterior chamber to prevent any potential pupillary block postoperatively.

In patients having DMD with scrolled edges, care shall be taken to inject air from an area opposite to the scroll so as to unscroll it. Precautions to be taken not to inject from an area that would exaggerate the scroll or increase the size of the DMD. All patients shall be explained the importance of posture depending on the site of the DMD.

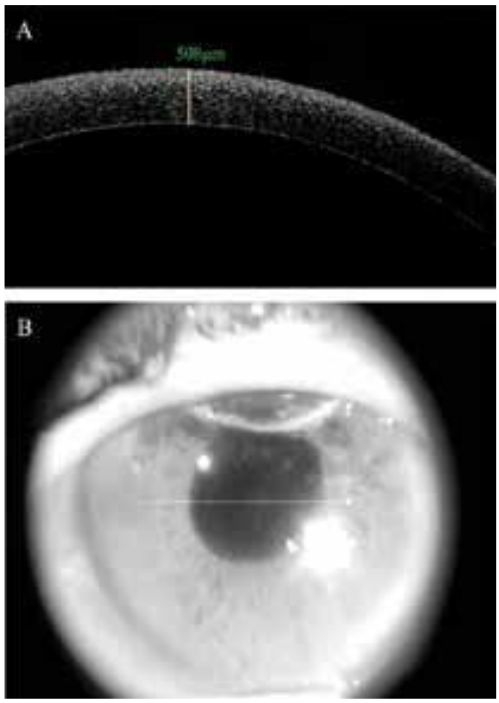
FOLLOW-UP

Post interventionally, topical 0.5% moxifloxacin hydrochloride ophthalmic solution 3 times a day and 1% prednisolone acetate ophthalmic suspension can be prescribed in tapering dosage for a period of 4 weeks. Patients can be evaluated on day 1, day 7, day 14, day 28, and at 6 weeks postoperatively. Parameters evaluated were visual acuity, IOP, corneal clarity, and any evidence of DMD on slit-lamp examination. Patients can also evaluated on the basis of UBM of the cornea for resolution of DMD. The anatomic outcome was defined as complete reattachment of Descemet membrane and the functional outcome was defined as the increase in BCVA and decrease in corneal edema.

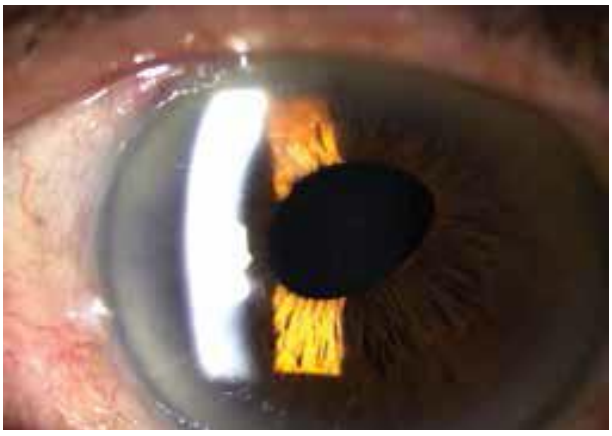
Slit-lamp photograph showing corneal edema



ASOCT imaging showing planar DMD
which masks DMD at 1-day follow-up visit
after phacoemulsification surgery



ASOCT imaging at day 1 after pneumodescemetopexy. Air bubble is seen in the anterior chamber with reattached Descemet's membrane



Slit-lamp photograph showing a clear cornea after pneumodescemetopexy

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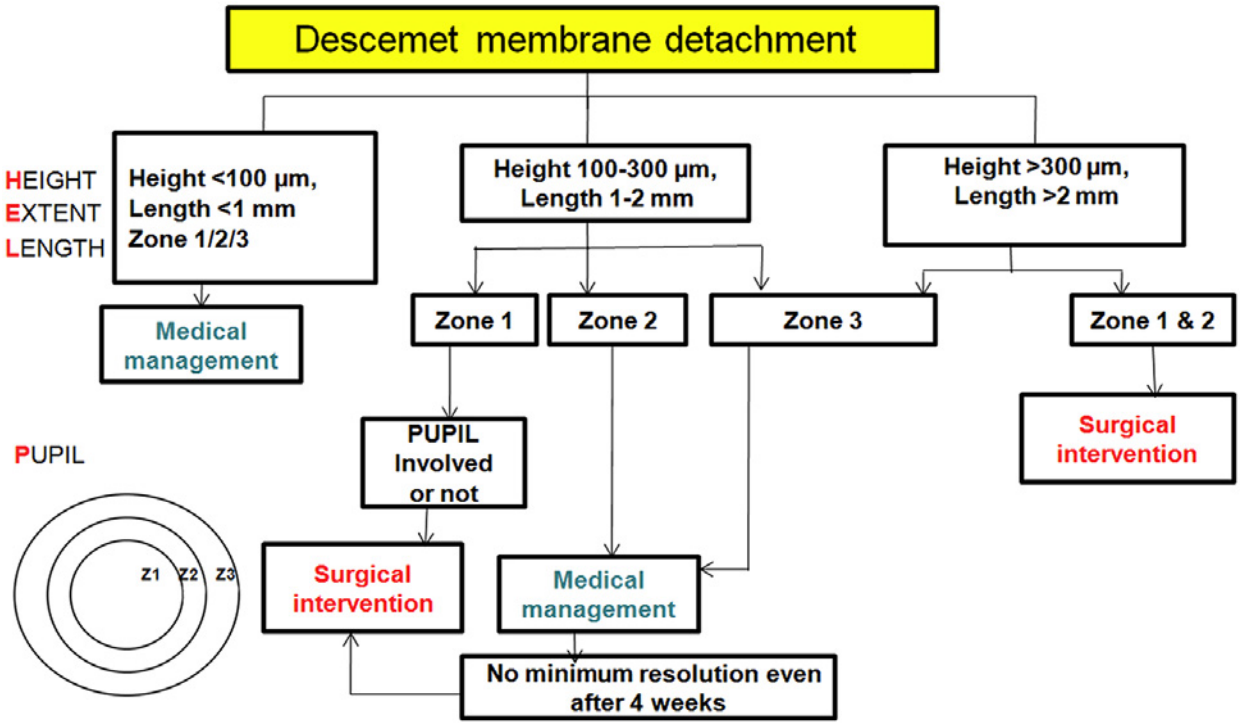
HEIGHT-, EXTENT-, LENGTH-, AND PUPIL-BASED TREATMENT PROTOCOL

The height and length (chord length) of the Descemet membrane detachment were measured in millimeters with AS-OCT using the calipers in the analysis tool . The extent of involvement in various zones of the cornea was determined, drawn in the zone map, and then classified in 3 zones as follows: zone 1 (central 5.0 mm), zone 2 (paracentral, 5.0 to 8.0 mm), and zone 3 (periphery, O8.0 mm). Zone involvement was evaluated clinically using slitlamp biomicroscopy and AS-OCT with undilated pupils and then noted in the Descemet membrane detachment treatment chart.

For a Descemet membrane detachment less than 1.0 mm long and less than 100 mm high in any zone, medical management was considered . When the Descemet membrane detachment was 1.0 to 2.0 mm with a height of 100 to 300 mm in zone 1 (with or without pupillary-axis involvement), surgery was considered. Descemet membrane detachments 1.0 to 2.0 mm long and 100 to 300 mm high in zones 2 and 3 were managed medically. Descemet membrane detachments longer than 2.0 mm and higher than 300 mm were treated surgically if in zones 1 and 2 and were managed medically if in zone 3.



ULTRASOUND BIOMICROSCOPY

Echographic evaluation of the anterior segment using an immersion or water bath technique can be a useful tool. When anterior segment pathology is noted or suspected and slit lamp and gonioscopic evaluation do not allow for adequate visualization of the cornea, anterior chamber, iris, iris angle, ciliary processes, and the anterior surface of the lens, immersion ultrasound can be used.

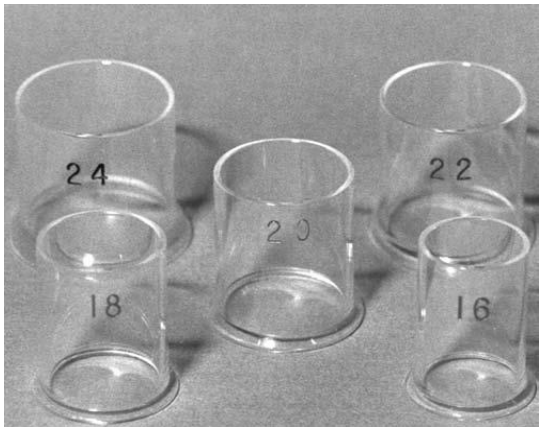
Conventional contact B-scan is of little use in evaluating anterior eye structures because of the required contact of the probe to the globe surface. Typically, there is a 5-mm area directly in front of the probe known as the “dead zone” where imaging is not possible. It is, however, possible to create a stand-off so the dead zone does not impede imaging.

This can be accomplished using scleral shells that are commercially available. These shells are small, plastic cups that come in different diameter widths to accommodate different eye and lid fissure sizes. They fit beneath the lids and can be filled with fluid to create the necessary stand-off. The probes can either be placed on top of the shell or immersed into the fluid-filled chamber. For some patients who have had recent surgery or trauma, inserting an inflexible scleral shell beneath the lids is not recommended. For these patients, a modified immersion technique can be used. To create a stand-off for this technique, the finger of a glove can be used to create a fluid-filled "balloon." This soft balloon can then be placed on the lids or the globe to evaluate anterior eye structures. The resolution of the images will not be as clear as those obtained with regular immersion techniques, but some useful information can be obtained.

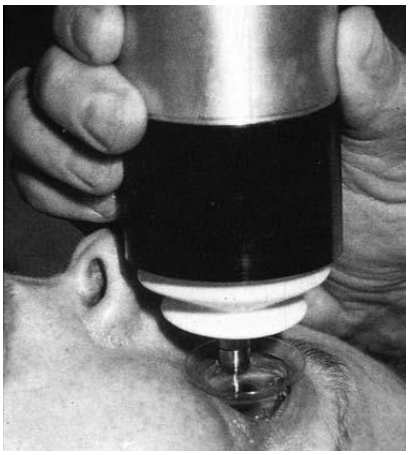
Over the last decade, higher-resolution equipment has emerged in ophthalmology. This equipment provides stunning images of the cornea, iris, lens, and ciliary body and has increased our ability to study anterior segment tumors, the mechanisms of glaucoma, intraocular lens positioning, corneal changes, and traumatized eyes. The ultrasound frequency of current contact B-scan transducers is around 10 MHz. The new generation, higher-resolution probes have frequencies that range from 20 to 100 MHz. The 20 MHz probe produces an image that is 10-mm wide, 12-mm deep,

and provides resolution in the 75-_m range. The transducer can be immersed into a water bath or a fluid-fill tonometer cover can be placed over the exposed piezoelectric crystal. The 50- to 100-MHz probes, also known as UBM (ultrasound biomicroscope), produce a 4-mm depth of penetration and provide resolution in the 50-_m range. These transducers work best when immersed in a water bath. Transverse, longitudinal, and axial scans can be performed using these probes; however, the marker orientations are somewhat different than those used for screening the posterior segment. Typically, the marker is directed toward the corneal limbus and pupil in longitudinal scans; however, for anterior segment evaluation using longitudinal scans the marker is directed away from the corneal limbus, toward the sclera. The designation for the marker using transverse scans is in any direction, but the recommended scanning procedure should be performed in a clockwise fashion.

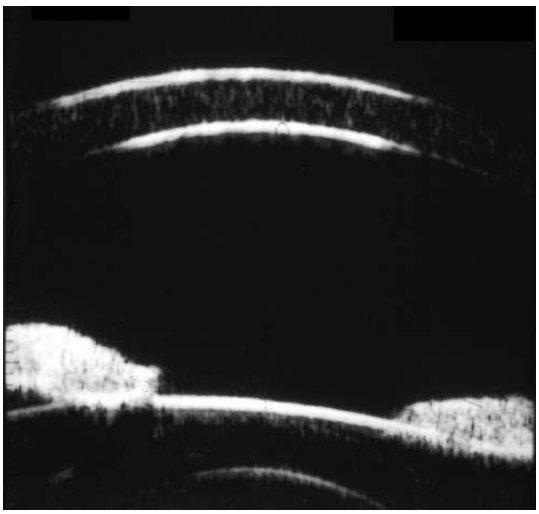
Each probe (10, 20, or 50–100 MHz) continues to provide useful echographic information with regard to anterior segment structures. It is the responsibility of the echographer to decide which frequency will provide the best information for the exam indication.



Immersion shells. Set of scleral shells for immersion technique/water bath. The numbers represent the diameter in millimeters.



The ultrasound biomicroscope with the UBM.



Normal cornea. Ultrasound biomicroscope (UBM) scan through the central axis. The two high reflective lines at the top of the scan correspond to the corneal layers. The corneal stroma is located between the lines.

PACHYMETRY

Pachymetry is derived from two Greek words: Pachos = thick + metry = to measure and is used for the measurement of corneal thickness. It was developed by Hendeson and Kremer in 1980.The thickness of the cornea is determined by the density and compressibility of cornea. It is indirectly an important indicator of health status of the cornea especially endothelial pump function of cornea. Cornea is composed of 78% water content. The thickness of the cornea was first reported in ancient textbooks on physiological optics (Helmholtz and gullstrand). Corneal thickness in normal eyes ranges from 700 to 900 microns at the limbus and varies between 480 microns and 520 microns at the centre . The Central corneal thickness (CCT) reading of 700 microns or more is indicative of endothelial decompensation.

Ultrasonic pachymetry , which is the most commonly used method, which is regarded as the gold standard. The principle of the instrument is that it functions by measuring the amount of time (transit time) needed for ultrasound pulse pass from the one end of transducer to descemet's membrane and back to the transducer. Corneal thickness = (Transit time × Propagation velocity) / 2 Speed of sound in cornea.

Propagation velocity of ultrasound waves in water is around 1524 m/s. Kremer chose 1640 m/s as the standard because the study conducted

in 175 eyes gave a corneal thickness of 512 +/- 0.035 with this value. Current standard adopted is 1640 m/sec .The components include a Probe handle, which has piezoelectric crystal piece that emits an ultrasonic beam of ~ 20 MHz, a transducer that sends ultrasound rays through the probe to the cornea and receives echoes from the cornea, a tip-the diameter of which should not be more than 2 mm.

The advantages are that it is faster, easy to use and simpler , repeatable and consistent between observers thereby eliminating inter observer variation, portable, dry (no coupling medium required) , can be used intra-operatively. The disadvantages are that it is a contact method, accuracy is dependent on the perpendicularity of the probe's application to the centre of the cornea, reproducibility relies on precise probe placement on the center of the cornea, low resolution and not accurate in edematous corneas.

Ultrasonic Pachymetry

REVIEW OF LITERATURE

1. Descemet Membrane Detachment After Phacoemulsification Surgery: Risk Factors and Success of Air Bubble Tamponade

Ti, Seng-Ei MMed(Ophth), FRCS(Ed) ; Chee, Soon-Phaik FRCS(Ed), FRCS(G) ; Tan, Donald T. H. FRCS(Ed), FRCS(G) ; Yang, You-Nian MPH ; Shuang, Stephanie L. MStat

Purpose: To evaluate the efficacy of air bubble (AB) tamponade for Descemet membrane detachment (DMD) after clear corneal incision phacoemulsification surgery and to evaluate the risk factors for DMD.

Results: Incidence rate of DMD was 0.044% per year. Sixteen patients (mean age of 76 years) had AB tamponade for DMD, with corneal clarity restored in 14 cases (87.5%; n = 11 with 1 AB procedure, n = 3 with 2 AB procedures). The main clear corneal incision was the major site of DMD (n = 14, 87.5%). Pre-AB visual acuity was 20/100 and at 1 month, 20/40. Corneal clarity occurred by 30 days (range: 4–82 days) and remained clear throughout the median follow-up of 12.9 months. Significant univariate factors were as follows: age >65 years, nuclear sclerosis grade ≥4 (Lens Opacities Classification System III), preexisting endothelial disease, and first POD corneal edema. Multivariate logistic regression analyses revealed endothelial disease (odds ratio = 18.66) and first POD edema (odds ratio =

7.88) as significant independent risk factors for DMD occurrence ($P < 0.05$).

Conclusions: AB tamponade for DMD effectively restored corneal clarity in 87.5% of cases (14 of 16 eyes). Significant risk factors included endothelial disease and first POD corneal edema.

2. **Anatomical and Visual Outcomes of Descemetopexy in Post Cataract Surgery Descemets' Membrane Detachment**

Dr. Rajat Jain, Dr. Somasheila Murthy, Dr. Sayan Basu, Dr. Md. Hasnat Ali, Dr. Virender Sangwan

This study compares the outcomes of descemetopexy post-cataract surgery with respect to the usage of air or C3F8. This is the largest such series, the first comparative study published so far and the first to report the association of various factors, which could be responsible for the final visual outcome in these patients.

Results : Multiple linear regression showed that the factors associated with a significantly poorer final visual outcome were found in patients with a cataract score of 5 (p=0.014), a cataract score of 4 with compromised visibility due to a corneal opacity (p=0.039) and prolonged duration between the cataract

surgery and descemetopexy (p=0.007). The factors associated with statistically significantly better IVA were found in patients in whom

phacoemulsification from the scleral incision (p=0.02) or conventional extracapsular cataract extraction (p=0.013) was done and in whom air was used as the agent for anterior chamber injection (p=0.009). No association of final visual outcome was seen with age, gender, eye treated, cataract scores 3 and 4, pre-operative visual acuity, involvement of the visual axis and intra-operative visibility, as regards the corneal pathology (p>0.5).

Conclusion : Descemet's membrane detachment is a rare occurrence, post cataract surgery. The majority of DMDs were noted in small incision cataract surgery at the ACM port in our series. An early intervention by descemetopexy was associated with a good final anatomical and visual outcome. Air descemetopexy is recommended over C3F8 injection, because of its equal efficacy and lack of complications. To our knowledge and after a literature search using PubMed, this is the only study that describes the risk factors for visual prognosis and compares the visual and safety outcomes of air and C3F8.

3. **Anterior Segment Optical Coherence Tomography–Guided Management Algorithm for Descemet Membrane Detachment After Intraocular Surgery**

Namrata Sharma, MD, Sandeep Gupta, MS, Prafulla Maharana, MD, Prakash Shanmugam, MD, Ritu Nagpal, MD, and Rasik B. Vajpayee, FRCSEd, FRANZCO

Purpose: To evaluate the role of anterior segment optical coherence tomography (ASOCT) in the detection and management of Descemet membrane detachment (DMD) in cases of persistent corneal edema after intraocular surgery. An ASOCT-guided new algorithm for the management of such DMDs is described.

Results: Using ASOCT, DMD was found to be present in 25 eyes. All cases had planar edges, and 52% (13/25) cases had scrolled edges. In 48% (12/25) cases, DMD was peripheral. Descemetopexy with intracameral air or 14% C3F8 gas showed resolution in all cases with the mean time to resolution being 16.0- 6 7.1 days.

Conclusions: ASOCT is a useful tool for timely diagnosis, characterization, and management of DMD in cases of nonresolving postoperative corneal edema. A new algorithm for intracameral injection of air or C3F8 in these cases helps to defer corneal transplantation.

4. Height-, extent-, length-, and pupil-based (HELP) algorithm to manage post-phacoemulsification Descemet membrane detachment

Dhivya Ashok Kumar, MD, FICO, Amar Agarwal, MS, FRCS, FRCOphth, Soundari Sivanganam, DNB, FRCS, Radika Chandrasekar, BSc PURPOSE: To analyze the functional and anatomic outcomes of management of Descemet membrane detachment after phacoemulsification

using a protocol based on the detachment's height, extent, and chord length and its relation to the pupil.

RESULTS: Of 161 eyes, 96 were treated surgically (Group 1) and 65 medically (Group 2). The mean length and mean height of Descemet membrane detachment were 2.4 mmG1.4 (SD) and 266G 189.8 mm, respectively, in Group 1 and 1.03 G 0.4 mm and 153.3 G 60.8 mm, respectively, in Group 2. The complete reattachment rate was 95.8% in Group 1 and 96.9% in Group 2. The corrected distance visual acuity (CDVA) was 20/40 or better in 83.3% of eyes in Group 1 and 92.3% of eyes in Group 2. No eye lost CDVA as a result of a Descemet membrane scar in the central 5.0 mm of the cornea. The AS-OCT allowed visualization of the detachment in all eyes with a CCT of more than 800 mm. There was no difference in the final CDVA between Group 1 and Group 2.

CONCLUSIONS: The AS-OCT–based algorithm was effective for managing post-surgical Descemet membrane detachment in eyes with dense corneal edema. Early surgical intervention for detachments in the central cornea can reduce scarring-induced visual loss.

AIMS AND OBJECTIVES

- To analyze the risk factors predisposing to Descemet's Membrane Detachments during conventional small incision cataract surgery .
- To also determine the association of these risk factors to final visual outcome after Air Bubble Tamponade.
- To grade the severity of Descemet's membrane detachment.
- To analyze the type of Descemet's membrane detachment.

STUDY DESIGN:

- This is a Prospective observational study.
- This study is to be conducted on 40 patients who have developed DMD following cataract surgery and attending the OPD as well as the wards of Ophthalmology department of GRH, Madurai.

Subjects are evaluated for entry into the study. Subjects who fulfilled all eligibility criteria, and none of the exclusion criteria, were recruited in our study.

STUDY CENTRE:

- Department of Ophthalmology, Govt.Rajaji Hospital, Madurai.

STUDY PERIOD

- 6 months (April – September 2017)

SAMPLE SIZE

- 40 patients

ETHICAL CLEARANCE

- Ethical Committee approval letter obtained

FINANCIAL SUPPORT

- Nil

METHODOLOGY

A total of 40 patients attending the OP as well as in the wards of Department of Ophthalmology ,GRH, Madurai who satisfy the inclusion criteria.

INCLUSION CRITERIA

- Patients within 50-75 yrs of age.
- Patients who have developed DMD following small incision cataract surgery
- Eyes with focal/sectoral corneal edema with CCT <800μ and associated DMD

EXCLUSION CRITERIA

- Previous history of trauma
- Post operative eyes with very dense corneal edema with CCT >800μ
- Pre-existing corneal opacities/scars
- Patients uncooperative for examination and unwilling for follow-up were excluded.

The patients who fulfill the above inclusion criteria were recruited from the OPD and post-operative ward of the study centre. A total of 40 patients will be recruited. The parameters to be analyzed are the demographic data and pre-operative ocular condition which shall be obtained from the patient's case file. Informed consent shall be obtained . The height and length of the DMD were measured by slit-lamp biomicroscopy and UBM and classified accordingly.

In all patients in whom DMD was documented and classified, descemetopexy will be performed using intracameral air with a standard technique as described below under the operating microscope, after frequent corticosteroid application and waiting for a few days.

RESULTS AND INTERPRETATION

STATISTICAL METHOD:

The information collected regarding all the cases were recorded in a Master Chart.

Data analysis was done with the help of computer using Statistical Package for Social Sciences (SPSS) software developed by IBM corporation.

Using this software- range, frequencies, percentages, means, standard deviations, ‘t’ value and ‘p’ values were calculated.

Student’s ‘t’ test, Chi square test were used to test the significance of difference between quantitative variables .

A 'p' value of less than 0.05 is taken to denote significant relation

OBSERVATIONAL ANALYSIS

TABLE 1 : AGE DISTRIBUTION

The mean age of the patients was 63.97+/-7.66 . About 47.5% of them were in the age group of 61-70 yrs.

Age in years	No.of cases	Percentage
< 50	2	5
51 - 60	13	32.5
61 - 70	19	47.5
> 70	6	15
Total	40	100

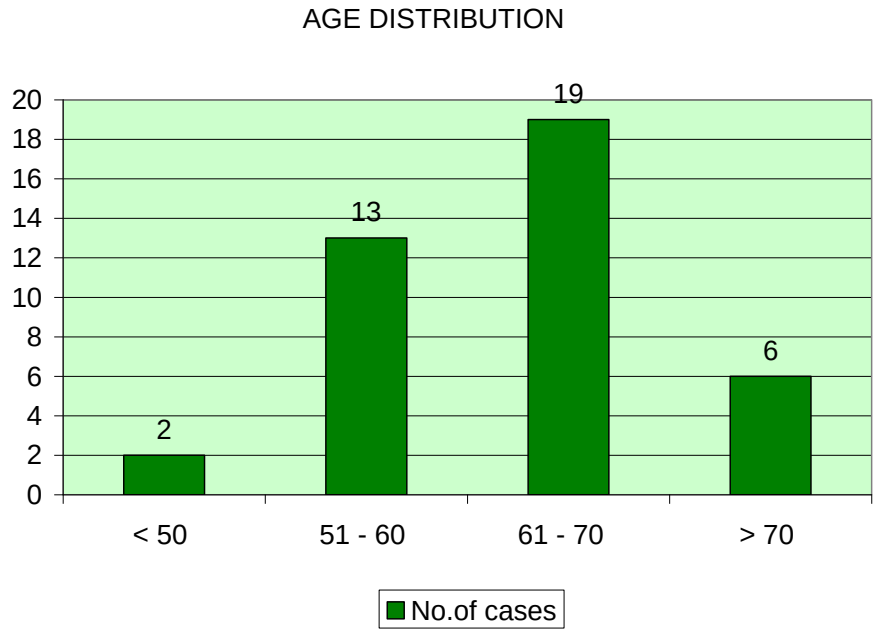


TABLE 2 : SEX DISTRIBUTION

There was equal distribution in the number of males and females affected. There was no specific sexual preponderance.

Sex	No.of cases	Percentage
Male	20	50
Female	20	50
Total	40	100

TABLE 3 : PREFERENTIAL EYE AND OCCURRENCE OF DMD

Out of 40 eyes that were studied , 24 cases were in the right eye and 14 in the left eye.

Side	No.of cases	Percentage
Right eye	24	60
Left eye	16	40
Total	40	100

TABLE 4 : SEVERITY DISTRIBUTION OF DMD

Of the 40 patients who had DMD , there were 2 mild, 5 moderate and 33 severe cases.

DMD	No.of cases	Percentage
Mild	2	5
Moderate	5	12.5
Severe	33	82.5
Total	40	100

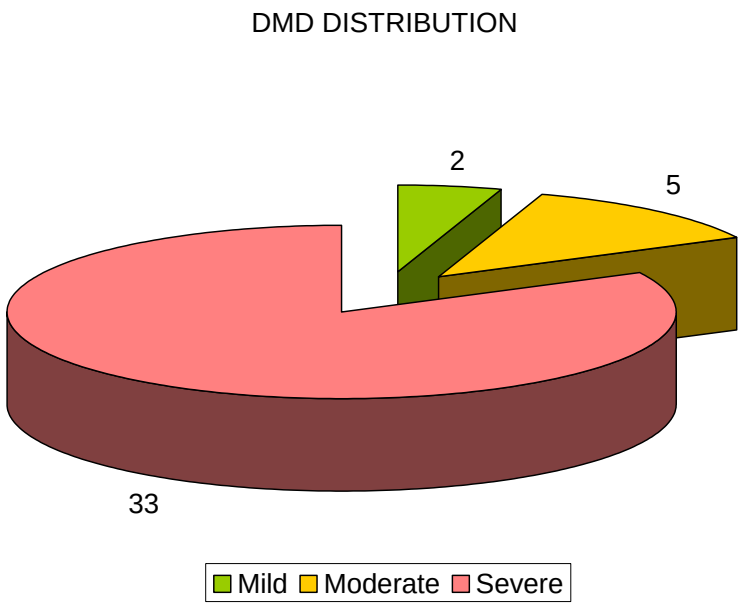


TABLE 5 : SEVERITY OF DMD IN SPECIFIC AGE GROUPS

In the study group , more severe DMD was found in the older age group of 61-70 yrs.

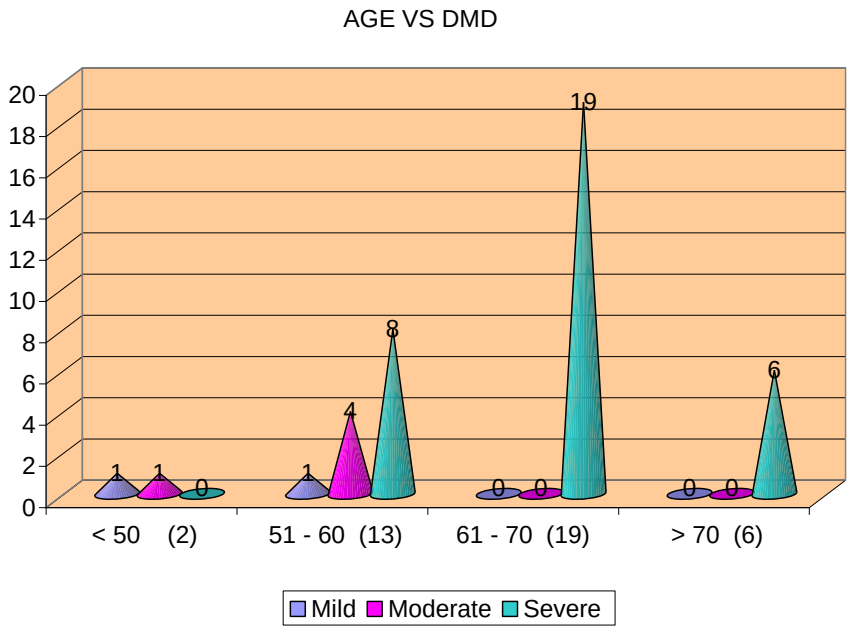


TABLE 6 : SEVERITY OF CORNEAL EDEMA

Severe corneal edema was found in 28 cases , moderate corneal edema in 10 cases and mild edema in 2 cases.

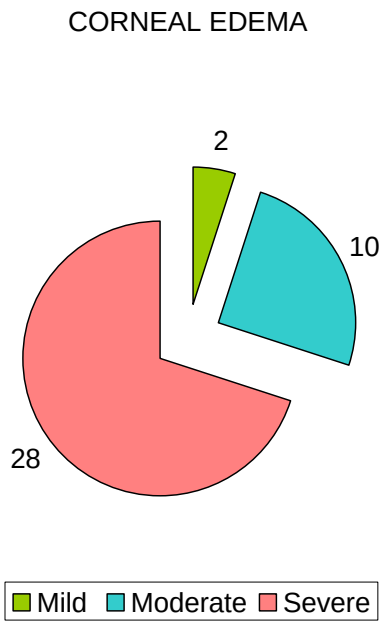


TABLE 7 : DISTRIBUTION OF DMD IN THE RISK FACTOR GROUPS

In the study group, there were Brown hard nuclear cataract and Pseudoexfoliation in 15 cases each ; 4 cases had Hypermature cataract ; 2 cases had thick arcus . there were no risk factors in 4 cases. Brown cataract and Pseudoexfoliation were found to be significant risk factors.

Risk factor	Mild	Moderate	Severe
BC (15)	0	0	15
HMC & MC (4)	0	1	3
PXF (15)	0	2	13
Thick arcus (2)	1	1	0
Nil (4)	1	1	2
Total (40)	2	5	33

			chi square value	p value
BC vs Other risk factor				
	15 / 15 vs	5 / 10	12.15	< **0.001 Sig**
PXF vs Other risk factor				
	13 / 15 vs	5 / 10	6.806	**0.009 Sig**

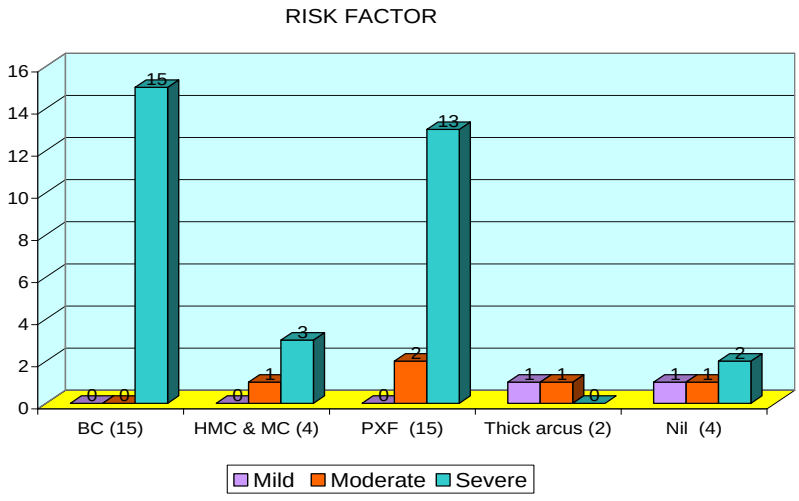


TABLE 8 : COMPARISON OF PRE AND POST –TREATMENT CCT MEANS

The mean pre-treatment CCT was 717.3µm as against the post – treatment CCT of 528.4µm.

CCT - treatment	Pre	Post
< 600	0	40
600-650	2	0
651 - 700	8	0
> 700	30	0
Mean	717.3	528.4
SD	33.2	5.2
p value	< 0.001 Significant	

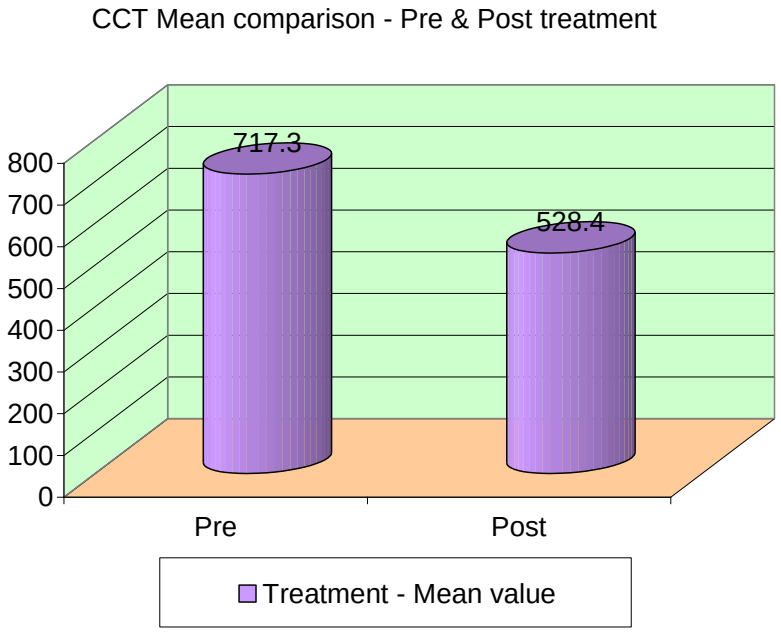


TABLE 9 : THE MEAN logMAR VISUAL ACUITY PRE AND POST TREATMENT

At one month, the logMAR VA improved from 1.7±0.44 to 0.45±0.12 with p<0.001 (significant)

TMT BCVA	Pre	Post
< 1	0	40
1 - 1.2	13	0
> 1.2	27	0
Mean	1.7	0.45
SD	0.44	0.12
p value	< 0.001 Significant	

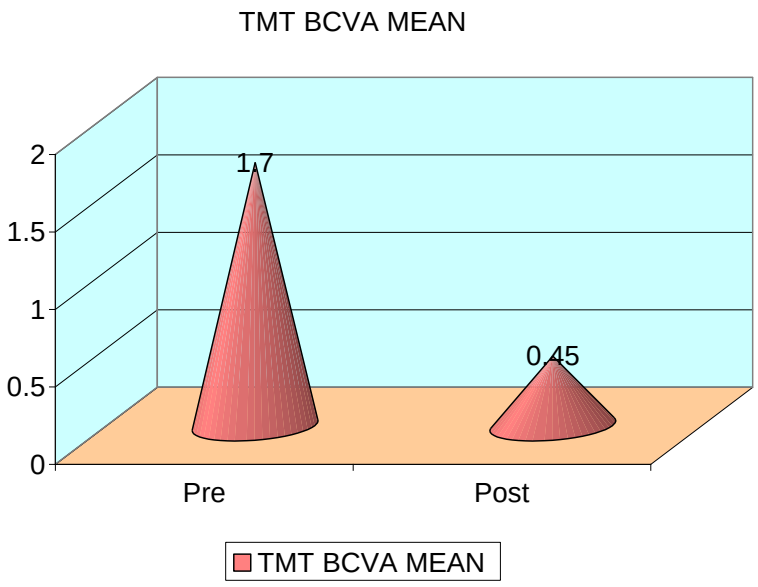


TABLE 10: SIGNIFICANCE OF SEVERITY OF DMD IN POST-TREATMENT BCVA

This study shows that more severe the DMD , the poorer will be the final visual outcome. ($p<0.001$)

BCVA	BCVA Mean	
	Pre	Post
Mild (2)	1	0.2
Moderate (5)	1.04	0.4
Severe (33)	1.85	0.51
p value	< 0.001 significant	

SUMMARY

- The mean age of the patients was 63.97+/-7.66 . About 47.5% of them were in the age group of 61-70 yrs.
- There was equal distribution in the number of males and females affected. There was no specific sexual preponderance.
- Out of 40 eyes that were studied , 24 cases were in the right eye and 14 in the left eye.
- Of the 40 patients who had DMD , there were 2 mild, 5 moderate and 33 severe cases.
- In the study group , more severe DMD was found in the older age group of 61-70 yrs.
- Severe corneal edema was found in 28 cases , moderate corneal edema in 10 cases and mild edema in 2 cases.
- In the study group, there were Brown hard nuclear cataract and Pseudoexfoliation in 15 cases each ; 4 cases had Hypermature cataract ; 2 cases had thick arcus . There were no risk factors in 4 cases.

- In the study group it was found that patients with risk factors like Brown cataract ($p<0.001$) and pseudoexfoliation ($p<0.009$) had more significant association with DMD as compared to the rest.

- The mean pre-treatment CCT was 717.3μm as against the post – treatment CCT of 528.4μm.

- At one month, the logMAR VA improved from 1.7±0.44 to 0.45±0.12 with $p<0.001$ (significant).

- In the study, the factors associated with a significantly poorer final visual outcome were found in patients with brown cataract ($p<0.039$); those with compromised visibility due to a persistent severe corneal edema (>5mm in diameter) and those with increased central corneal thickness(>650μ) at the time of presentation .

- The study also shows that more severe the DMD, poorer the final visual outcome ($p<0.001$).

DISCUSSION

Descemet membrane detachment is a distinct clinical entity that has been known to ophthalmic surgeons as a postoperative complication for many years. Some common causes are a shallow anterior chamber, accidental insertion of the instruments between the corneal stroma and Descemet membrane, use of blunt microkeratomes, inadvertent injection of saline or ophthalmic viscosurgical device in the space between the stroma and Descemet membrane, genetically related weak adhesions between the stroma and Descemet membrane, preoperative glaucoma, recent onset of corneal edema, and a-chymotrypsin. Monroe gonioscopically determined that localized Descemet membrane detachment was common (43%) in eyes having cataract surgery.

There have been many reports, reviews, and case series of the management of Descemet membrane detachment. The initial classification of Descemet membrane detachment was given by Mackool and Holtz as planar (<1.0 mm) and nonplanar (>1.0 mm). They postulated that all nonplanar Descemet membrane detachments require surgical intervention and that the absence of the Descemet membrane scroll has been indicated as a factor in spontaneous recovery, even in cases with a large Descemet membrane detachment. Jain et al. graded Descemet membrane detachment after small-incision cataract surgery as mild, moderate, or severe,

depending on the percentage of corneal involvement, and reported the results after descemetopexy.

When the Descemet membrane detachments were left to attach spontaneously, the potential for full visual recovery decreased because of the formation of residual Descemet membrane folds, wrinkles, fibrosis, pre-Descemet membrane pigments, opacities, or scars. When these develop in the pupillary region or zone 1, the potential for visual disturbance will be high. Those eyes need to be treated aggressively even though the intensity of the Descemet membrane detachment was small. The delay in intervention can be deleterious to functional outcomes when zone 1 and the pupils are involved.

Zone 3 is in the periphery of the cornea and the potential for visual impairment, even after scarring, is lower; in Zone 2, when the Descemet membrane detachment did not show minimum signs of resolution after 4 weeks, it had to be managed surgically. The reason for early intervention was that persistent zone 2 Descemet membrane detachment can lead to chronic nonresolving corneal edema and thereby induce scarring with endothelial wrinkling, which can reduce visual acuity.

In a study by Rajat Jain et al, Multiple linear regression showed that the factors associated with a significantly poorer final visual outcome were found in patients with a cataract score of 5 ($p=0.014$), a cataract score of 4

with compromised visibility due to a corneal opacity (p=0.039) and prolonged duration between the cataract surgery and descemetopexy (p=0.007). This is similar to the present study in which poor visual outcome was associated with brown cataract ($p < 0.001$) and pseudoexfoliation ($p<0.009$).

In another study by Namrata Sharma et al, AS-OCT based protocol was created for management of DMD based on which intracameral air or C3F8 was used. In the present study, only air bubble tamponade was used to treat the DMD. Of 40 eyes, only one eye required repeat air injection and one eye did not require any intervention. 100% of DMD which underwent intervention were reattached successfully. No eye developed a reaction (uveitis or infection) after air injection thus signifying that air bubble tamponade is equally effective and safe procedure.

CONCLUSION

In this era in which many patients expect the best visual outcomes in the immediate postoperative period, managing Descemet membrane detachments is very essential. In this study, the factors associated with a significantly poorer final visual outcome were found in patients with brown cataract; those with compromised visibility due to a persistent severe corneal edema and those with increased central corneal thickness at the time of presentation . Moreover brown cataract and pseudoexfoliation were found to be significant risk factors for development of Descemet's Membrane Detachment. No association of final visual outcome was seen with age, gender, eye treated and pre-operative visual acuity. In the present study, severe Descemet's Membrane Detachment (involving zone 1 and >50% of cornea) was associated with poorer visual outcome. This study also shows that through early surgical intervention, even in cases with small Descemet membrane detachments, we prevented the visual loss caused by Descemet membrane scarring. Thus timely surgical intervention in Descemet's membrane detachments might prevent complications such as fibrosis, shrinkage, and wrinkling of Descemet membrane, which can subsequently prevent reattachment. Moreover intervention by pnemodescemetopexy (Air Bubble tamponade) was associated with a satisfactory final anatomical and visual outcome.

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PROFORMA

NAME

AGE/SEX

IP/OP NO.

OCCUPATION

PRE-OPERATIVE OCULAR CONDITION:

DATE OF SURGERY

INTRA-OPERATIVE PERIOD

OBLIQUE EXAMINATION

OD	**OS**
	LIDS
	CONJUNCTIVA
	CORNEA
	AC DEPTH
	IRIS
	PUPIL
	LENS
	VISUAL ACUITY (uncorrected)
	IOP (BY NCT)

SLIT-LAMP BIOMICROSCOPY

OD

OS

LIDS

CONJUNCTIVA

CORNEA

EDEMA/HAZE

DMD

- Zone
- Length
- Type

ANTERIOR CHAMBER

IRIS

PUPILS

LENS

ULTRASOUND BIOMICROSCOPY (length of the DMD):

DATE OF SURGICAL MGMT. :

PROCEDURE DONE :

POST-OPERATIVE EXAMINATION

POST OPERATIVE DAY	SLIT-LAMP EXAMINATION		VISUAL ACUITY	
	STATUS OF DMD	CORNEAL CLARITY	UCVA	BCVA
DAY-1				
DAY – 7				
DAY – 14				
DAY – 28				
AT 6 WEEKS				

LIST OF ABBREVIATIONS

- DM – Descemet's Membrane
- DMD – Descemet's Membrane detachment
- BC – Brown cataract
- PXF – Pseudoexfoliation
- HMC – Hypermature Cataract
- MC – Mature Cataract
- BSK – Band Shaped Keratopathy
- CCT – Central Corneal Thickness
- UCVA – Uncorrected Visual Acuity
- BCVA – Best Corrected Visual Acuity
- Pre –TMT – Pre – treatment
- Post – TMT – Post- Treatment
- ABT – Air Bubble Tamponade
- IOP – IntraOcular Pressure
- NCT – NonContact Tonometer

S.NO.	NAME	AGE	SEX	EYE	DMD SEVERITY	CORNEAL EDEMA	RISK FACTOR	PRE-TREATMENT CCT	INTER VENTION	POST-TMT CCT	PRE-TMT BCVA	POST-TMT BCVA
1	PAPPA	60	F	RE	SEVERE	MODERATE	BSK	696	ABT	529	1.2	0.4
2	MURUGAN	70	M	RE	SEVERE	SEVERE	MC	740	ABT	545	2	0.8
3	SEVALKODI	62	F	RE	SEVERE	SEVERE	BC	752	ABT	534	2	0.6
4	LAKSHMIKANTHAM	62	F	RE	SEVERE	MODERATE	HMC	668	ABT	525	1.1	0.4
5	MEENAKSHI	53	F	RE	MODERATE	MODERATE	PXF	674	ABT	522	1	0.4
6	PAULRAJ	71	M	LE	SEVERE	SEVERE	PXF	736	TWICE-ABT	536	2	0.6
7	RAMASAMY	60	M	RE	SEVERE	SEVERE	BC	728	ABT	529	2	0.5
8	MUTHUKARUPPAN	60	M	RE	SEVERE	SEVERE	PXF	747	ABT	532	2	0.6
9	PODHILI	63	M	LE	SEVERE	SEVERE	PXF	731	ABT	526	2	0.4
10	LAKSHMI	55	F	LE	MILD	MILD	THICK ARCUS	622	NIL	524	1	0.2
11	PAPPATHY	65	F	LE	SEVERE	SEVERE	BC	729	ABT	537	2	0.6
12	BAKYAM	68	F	RE	SEVERE	SEVERE	HMC	730	ABT	532	2	0.6
13	CHRISDANIYAMMAL	83	F	LE	SEVERE	SEVERE	PXF	714	ABT	526	2	0.4
14	JAKKAMMAL	70	F	LE	SEVERE	SEVERE	BC	723	ABT	520	2	0.4
15	OTCHAMMAL	50	F	RE	MODERATE	MODERATE	MC	702	ABT	522	1	0.4
16	DEVI	42	F	RE	MILD	MILD		603	NIL	524	1	0.2
17	UKKIRAPANDI	68	M	RE	SEVERE	SEVERE	PXF	735	ABT	530	2	0.6
18	NATESAN	67	M	LE	SEVERE	SEVERE	BC	728	ABT	532	2	0.6
19	SRINIVASAN	72	M	RE	SEVERE	SEVERE	PXF	744	ABT	524	2	0.4
20	KURUVAN	60	M	LE	SEVERE	SEVERE	PXF	743	ABT	534	2	0.6
21	AYESHA	60	F	LE	SEVERE	MODERATE		678	ABT	521	1.2	0.3
22	ADAIKALAM	70	M	RE	SEVERE	SEVERE	PXF	724	ABT	527	2	0.4
23	IRULANDIDURAI	78	M	LE	SEVERE	SEVERE	BC	732	ABT	528	2	0.4
24	PERIYAMAYAN	57	M	RE	MODERATE	MODERATE	PXF	684	ABT	526	1.2	0.5
25	DHANAM	70	F	RE	SEVERE	SEVERE	PXF	733	ABT	530	2	0.6
26	POOVATHI	64	F	RE	SEVERE	SEVERE	BC	735	ABT	529	2	0.4
27	MEENA	54	F	LE	MODERATE	MODERATE		741	ABT	532	1	0.4

28	SUSILA	65	F	LE	SEVERE	MODERATE		687	ABT	523	1.1	0.3
29	PALANI	72	M	RE	SEVERE	SEVERE	BC	738	ABT	529	1.2	0.4
30	KARUPPAIYA	60	M	LE	SEVERE	SEVERE	BC	742	ABT	536	2	0.6
31	MUTHUAIYA	70	M	RE	SEVERE	SEVERE	BC	736	ABT	533	2	0.4
32	ALAGI	64	F	LE	SEVERE	SEVERE	BC	737	ABT	531	2	0.4
33	IRULAPPAN	68	M	RE	SEVERE	SEVERE	PXF	741	ABT	526	2	0.4
34	NAGAMMAL	60	F	RE	SEVERE	SEVERE	PXF	732	ABT	530	2	0.5
35	MOOKAYEE	59	F	LE	SEVERE	MODERATE	PXF	695	ABT	524	1.1	0.4
36	KARUTHAKANNAN	65	M	LE	SEVERE	SEVERE	BC	730	ABT	528	2	0.4
37	BACKIYAM	56	F	RE	MODERATE	MODERATE	THICK ARCUS	680	ABT	524	1	0.3
38	PANDI	68	M	RE	SEVERE	SEVERE	BC	731	ABT	526	2	0.4
39	ANANDAKRISHNAN	71	M	RE	SEVERE	SEVERE	PXF	738	ABT	523	2	0.4
40	MUTHU	67	M	RE	SEVERE	SEVERE	BC	732	ABT	525	2	0.4
											1.7025	0.45

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Research Topic	:	An analytical study to determine the risk factors for descemet membrane detachment among patients requiring cataract surgery
Ethical Committee as on	:	21.04.2017

The Ethics Committee, Madurai Medical College has decided to inform that your Research proposal is accepted.

Member Secretary Chairman Dean / Convenor

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AN ANALYTICAL STUDY TO DETERMINE THE RISKFACTORS FOR DESCEMET'S MEMBRANE DETACHMENT FOR PATIENT'S AWAITING CATARACT SURGERY

INTRODUCTION

Descemet's membrane is a thick basement membrane that lines the posterior surface of the cornea above the corneal endothelium. It is made up of collagen(73%) and glycoproteins. The collagen differs from typical connective tissue collagen in that it lacks the typical 640-A banded collagen fibrils and have a high content of hydroxyproline, glycine and hydroxyglycine. Unlike stroma , the Descemet's membrane does not contain glycosaminoglycans. The collagen is insoluble and extremely resistant to chemical and enzymatic actions. This accounts for the resistance offered by Descemet's membrane (DM) to trauma, chemical agents, infection and a barrier to perforation in deep corneal ulcers. In ocular physiology, Descemet membrane with it's endothelium has a vital

CERTIFICATE

This is to certify that this dissertation work titled **"AN ANALYTICAL STUDY TO DETERMINE THE RISKFACTORS FOR DESCEMET'S MEMBRANE DETACHMENT FOR PATIENTS AWAITING CATARACT SURGERY"** of the candidate DR.VIDHUBALA.G with registration number 221613106 for the award of M.S Degree in the branch of Ophthalmology . I personally verified the urkund.com website for the purpose of plagiarism check. I found that the uploaded thesis file contains from Introduction to Conclusion pages and the result shows 8% of plagiarism in the dissertation.

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